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SWITCHING AND CONTROLLING APPARATUS FOR BOOSTERS.

The ordinary means of cutting out an electrical generator in case of emergency are not sufficient for the dynamo using a booster, owing to the peculiar nature of its winding and load. Especially is this the case in series-wound, motor-driven boosters, such as those described in the article on the power plant of the Capital Traction Company on other pages of this issue. Here the boosters are used to raise the voltage of the current supplied to the longest feeders, the generating end being series-wound and direct-coupled to a 600-volt motor supplied with power from the main circuit. The contingency which calls for a special protective apparatus is the opening of the motor circuit. In this case the torque generated between the armature and field of the booster generator tends to reverse the direction of rotation of the machine, and—as it is series-wound—it tends to run away as a series motor. This accident is provided against by connecting the "tell-tale" of the motor circuit breaker through a battery circuit with an electromagnetic relay, which in turn closes the circuit of an auxiliary magnet on the booster circuit breaker, tripping it and opening the booster circuit. This rather indirect method of control might be improved by using a double-pole circuit breaker instead of the single-pole breaker in the motor circuit, the added pole being connected up in the booster generator circuit. Both circuits would then be opened simultaneously.

Either method, however, involves the opening of the feeders supplied by the booster whenever the latter is thrown out of service, and if this is not immediately noticed by an attendant these feeders and corresponding line sections may be without current for some time. A better method would seem to be the provision of some arrangement for throwing the "boosted" feeders over from the booster to the main bus, so that whenever it became necessary to put the machine out of service either automatically or manually, the feeders will be immediately given a source of current which even at a lower voltage would be better than throwing them on open circuit. A simple means of accomplishing this and also of cutting the booster in and out without even an instantaneous interruption of the current supply could be obtained by short-circuiting the series field of the booster-motor instead of opening the same circuit. This would allow the current to pass idly through the booster armature without any danger of runaway, and after the machine had come to a standstill the armature could be short-circuited and the machine cut out without opening the feeder circuit at any instant. The switching over of a railway feeder without opening it is, of course, advisable wherever possible, owing to the destructive nature of the arcs at the switch blades under heavy load, and the consequent necessity of opening by means of circuit breakers instead of switches, which requires an elaborate sequence of operations difficult for the switchboard attendant to remember in times of emergency. It might be objected that the booster would give trouble with its field short-circuited, owing to the lack of a commutating field but boosters in storage-battery service are now regularly run with differential windings, which often neutralize each other's exciting tendency, giving zero field magnetization, with no troublesome sparking, in spite of heavy currents flowing.

With engine-driven boosters there is no need of special appliances for shutting down the generator when the supply of power to the driving machine ceases. The steam can hardly be cut off from

the engine except intentionally, and the reversal of the direction of rotation would instantly be noticed and remedied by a man at the throttle-valve. Engine-driven boosters are, it may be remarked here, rarely used for feeder work, owing to the peculiarly violent fluctuations of the load, which varies as the square of the current output, since the voltage generated by the machine is proportional to the current, and the watts, therefore, are proportional to the square of the current. It is hard enough to make a steam-engine governor regulate well on a load as fluctuating as that of a single section of a street railway, but when the changes of this load are squared the condition is peculiarly difficult to meet.

The other common use of boosters is for controlling storage-battery currents, and to render a storage battery suitable for over-compounded systems they are absolutely necessary, as, without them, the storage-battery load would increase with increased external load and aggravate the variations in engine and dynamo load. Boosters so used are generally differentially wound, one field winding of comparatively fine wire being connected across the mains and giving an excitation which, by means of a reversing rheostat, may be made to give a booster voltage, helping constantly either to charge or to discharge the batteries at the will of the manipulator. The other winding is of comparatively large wire and carries a current proportional to the external load of the system, being for this purpose generally introduced between the equalizer and the main bus in parallel with the series field windings of the generators. This winding is so connected up as to increase the voltage, helping to discharge the battery with increased station load, and vice versa, and may be so proportioned as to give an excitation dependent upon the load sufficient to make the battery take up all fluctuations, rendering the load on the engines and main dynamo practically constant, a condition highly conducive to steam economy. Such boosters are best motor-driven, as both field magnetization and armature current are reversed often not simultaneously, the booster proper often running as a motor instead of as a dynamo, a condition rather hard for the steam engine governor to meet.

ENGLISH VIEWS OF ELECTRICAL TRACTION.

The installation of electric street railways, or, as the English call them, electric tramways, in the cities of Great Britain is handled with a strange mingling of engineering conservatism and economic liberalism. For a long time England held out against the overhead trolley on the score of its unsightliness, but now that a superior system—the open conduit—has been developed in Germany and this country, the English technical press opposes it bitterly. The London "Electrical Review," in a recent discussion of the matter, claims rightly that the conduit costs at least from two to three times as much as an overhead trolley system, but states that such tramways would only prove to be very remunerative in such crowded thoroughfares as Broadway, in New York, and similar lines. The strangest part of this discussion is the fact that the English authorities still, as a rule, hesitate between a cable system and the overhead trolley, in spite of the fact that the cable is, as a rule, more expensive in the matter of first cost, in power, in maintenance of equipment, and in maintenance of way, per car mile, than is the open conduit electric. Thus, in spite of the hue and cry about the prohibitive cost of the latter, the cable road, which is more costly in every way and gives a far less reliable and less flexible and generally less satisfactory service, is often considered, although at present rarely adopted.

In contrast with this engineering conservatism there is in England a marked tendency toward municipal ownership which it is difficult for students of economics in this country to understand. This is largely due to the attitude originally assumed by English cities toward their street railways. Starting as horse-car lines, the authorities took the position that the road bed was a part of the street, and should therefore be constructed by the city, as was the rest of the street, and leased to the highest bidder. This plan proved very satisfactory with the small capital investment in equipment of tramways operated by horse-power, but when mechanical traction began to come into vogue it became apparent that the operators of the system should also own the whole of it. The English being more considerate of public as against private rights, and perceiving the dangers of abuse in long-term franchises, have in many places decided to have their tramways operated directly by the municipal authorities, although some still lease the lines to operating companies. Glasgow was the first such city, the municipal service starting in 1894, and owing to the policy of keeping down profits the fares have been reduced, the service increased and the hours of employees reduced and the wages raised. Other towns are rapidly following in the same line, among them Liverpool, Leeds, and Sheffield. Manchester will start an electrical system in full sway next spring. This policy of collectivism, or, as some would call it, socialism, appears to give good satisfaction in England, although on account of the civil service abuses in this country it is doubtful if it can be safely introduced here before many years.

ENGINE-ROOM FLOORS.

There is in this country quite a varied practice in the construction of engine-room floors. Most power-station designers prefer a concrete floor with a cement surface, supported on brick, tile or concrete arches, sprung between steel beams, as in ordinary fireproof office-building construction. Some prefer cast-iron plates and gratings, giving light and ventilation to the basement below.[1] Others use a concrete floor framed integrally with concrete beams, the whole set at one time over wooden false-work with twisted or knotted iron rods in the lower sides of the beams to take the tensile strains.[2]

In the description, on other pages, of the power plant of the Capital Traction Company it will be noticed that the engine-room floor is finished in wood. While this may appear at first sight to be a return to dangerous principles, it possesses many elements of value which engineering visitors to the station will instantly recognize. The chief reason for its use in this case was the added comfort of the attendants who are required to walk and stand upon the floor for many hours each day. The discomfort of standing on as rigid a flooring as cement is a feature not sufficiently considered in engine-room design.

A further advantage presented by the wooden floor is the improved appearance of the room, a great indirect advantage in the pride which it induces in the men in charge and the care they take with the whole of the installation. Oil and grease soak into cement flooring and leave unsightly stains that are totally absent from the polish of a nicely finished wooden floor. The danger of fire is not as great as might appear. There is in this particular example cited, and should be in all cases, no air space below the flooring, the sleepers to which the flooring is nailed being bedded flush in concrete, so that the flooring proper sets directly upon it. Fire, unless it be a very hot one, will not run on an upper exposed horizontal surface, so that, other woodwork being suppressed, this will not be a source of any great danger.

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[1] See The Electrical World, April 30, 1898, page 527.

[2] See The Electrical World, June 11, 1898, page 703.

The Open-Conduit Electric System of the Capital Traction Company.

THE city of Washington is, on account of the great width of its streets as well as their beauty, peculiarly ill-adapted to the overhead-trolley system, and on account of the almost universal use of asphalt paving and the favorable climatic conditions peculiarly well adapted to the operation of open conduits. The lines of the Metropolitan Railroad Company have been operated in this manner for several years, and the Capital Traction Company has had in service a short line fitted with the Love conduit system. When, therefore, the great power house of the Capital Traction Company was completely destroyed by fire on the night of September 29, 1897,[1] there arose the alternative of rebuilding the cable equipment or replacing it with an electrical system. Four days after the fire the directors decided definitely to adopt the underground electric system for the Pennsylvania Avenue and Fourteenth Street lines, and a building committee was appointed to lay out the enormous amount of special work which the occasion called for, and called for in a hurry, in order to get the line in operation again as soon as possible.

THE RECONSTRUCTION OF THE TRACKS.

The track system adopted was the same as that in use by the Metropolitan Railroad Company in Washington and by the Metropolitan Street Railway Company in New York City,[2] with such changes as were necessary to adapt it to the existing cable tracks. Twenty-two miles of track (see Fig. 1) have been changed over, including the Seventh Street line, which was kept in operation by cable while the change was being made; the Love conduit system on U Street will later be rendered uniform with the rest. This renders the company's whole system electrical.

A 24-duct conduit for the electrical cables was laid midway between the two tracks, except where deflected by existing pipes and ducts, the material used being vitrified clay pipes, and wrought-iron cement-lined pipes are laid in concrete in the ordinary way. Temporary tracks were laid down for the horse cars on Pennsylvania avenue and Fourteenth Street, so that the track work could be carried on without interruption. The cable conduit—18 inches wide by 38 inches deep—was fortunately made of concrete, plaster-lined, and without any inside metal sheathing. Entrance to it was obtained by means of manholes at intervals of 31½ feet, running from the slot rail to the outer track rail, as shown at the right hand side of Fig 3.

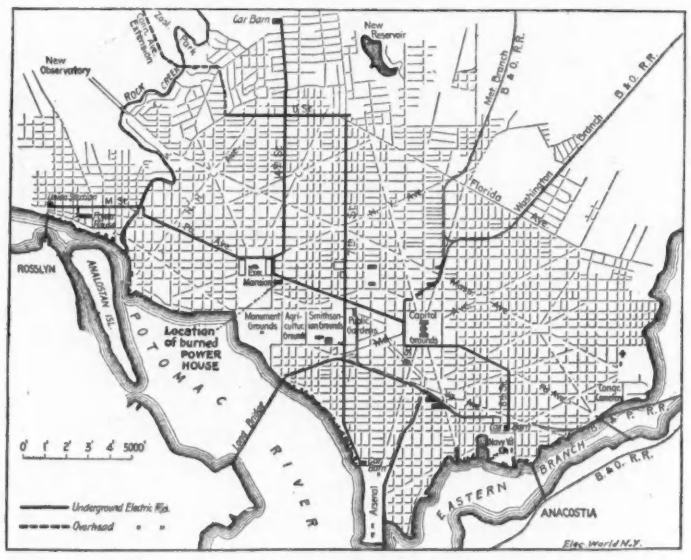


FIG. 1.—MAP OF THE CAPITAL TRACTION COMPANY'S SYSTEM.

The conductor rails for the new electrical work are of steel, T-shaped, 4 by 2 inches, weighing 23 pounds to the yard, and having the conductivity of 300,000 circular mils of copper. They were cut into 31 foot 6 inch sections to span the distance between these manholes in which the insulating supports for the outer rail were placed. To hold the other conductor rail a small handhole was put in immediately across the slot from the manhole, as shown at the left-hand side of Fig. 3. and to give an intermediate support

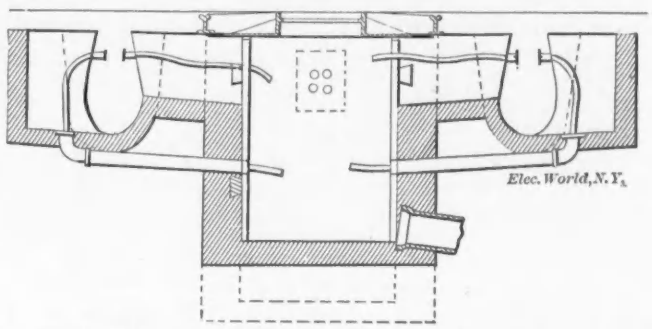


FIG. 2.—THE DRAW-IN MANHOLE, SHOWING TAPS TO CONDUCTOR RAILS AND METHOD OF DRAINING.

at the middle of the rail length a pair of similar handholes was put in midway between manholes. The conductor rails were inserted through slot hatches which were placed at intervals of about 800 feet, one of which shows clearly in the foreground of Fig. 8.

The porcelain insulators are supported, as Fig. 3 shows, by cast-iron caps with ears, which are bolted to the foot flanges of the slot rails. The holes for these bolts were made by punching machines as soon as the excavations for the handholes had been made. The two holes in the web of the slot rail for the attachment of each cast-iron handhole frame were made by a specially designed drill let into the excavation and backed up against the track rail. Knock-down frames were then placed in the excavations, making an inside form for the concrete shells of the handholes, which are 5 inches in thickness, internally plastered with cement mortar.

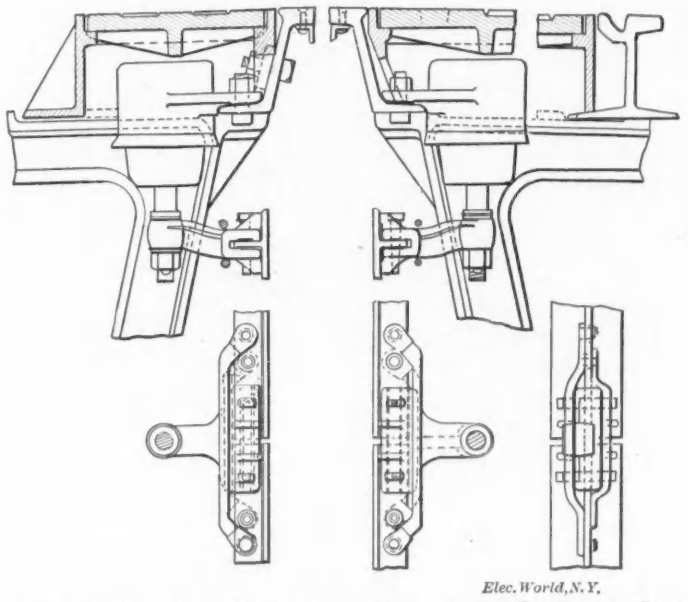


FIG. 3.—THE INSULATING SUPPORT AND BOND OF THE CONDUCTOR RAIL

To prevent the water entering the slot from trickling down the sides and dripping over the conductor rails, which are 6 inches apart, the upper flange of the slot rails in such a road must be fitted with a downwardly projecting lip, from which all water will drip

[1] See THE ELECTRICAL WORLD, October 9, 1897, page 417.
[2] See THE ELECTRICAL WORLD, August 28, 1897, page 239; September 18, 1897, page 328; September 10, 1898, page 258.

off and fall between the conductor rails to the bottom of the conduit. There was, of course, no such lip on the old cable rails, and rather than replace them, bedded as they were in good asphalt paving, it was decided to rivet steel 1 by 1 inch angle sections to them in the manner clearly shown in Fig. 3. The angles were let down through the slot and held up against the lower face of the slot-rail head by a specially designed tool, and rivet holes were drilled through both at intervals of about 4 feet. A gang of laborers at this work is shown in Fig. 9. The holes are countersunk from the top and the rivet heads finished flush with the surface.

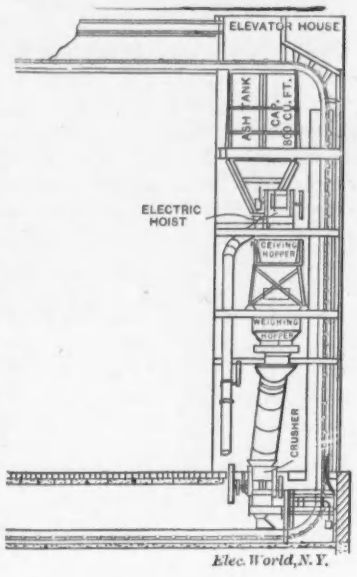


Fig. 4.—Vertical Section of the Conveyor Tower.

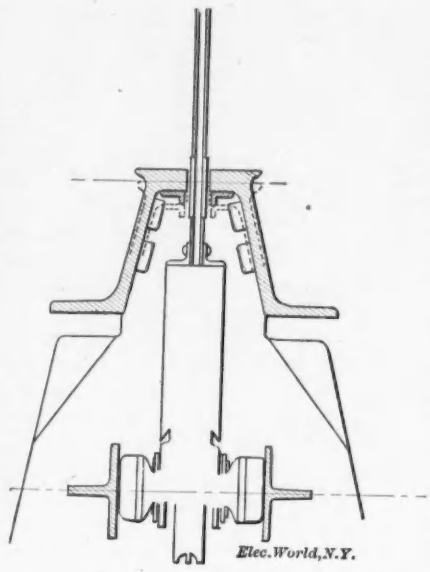


Fig. 5.—Slot Rails, Conductor Rails and Plow.

The old track-rail ends were pretty badly dropped, and it was decided to bring them up by the well-known cast-welding process. The fishplates were removed, the rail ends cleaned by hand, no power being available, for a distance of about 10 inches back from the joint, and the splice-bar bolt holes in the rails were plugged, the iron plugs projecting about an inch on each side of the web so as to become bedded firmly in the casting. Strips of iron of the rail section were driven between the abutting ends, making the joints tight. The flattened rail of each joint was shimmed up a trifle higher than the other, and the usual cast-iron mould was clamped about the hole and filled with molten iron poured from a portable furnace, as shown in Fig. 8. The heating of the steel was found to bend the ends upward to just about a true bearing, a smooth joint being assured by finishing the surface by hand filling. The joints now ride very smoothly, but few of them being perceptible.

The conversion of the Seventh Street line, which was kept in operation by cable as noted above, except during a few hours of each night, was still more difficult. The laying of the ducts and the setting of handhole castings and insulators were done in the daytime. At night the workmen entered the conduits and secured the conductor rails to the clips of the insulating supports. The cast welding of the rail joints on this line was done several years ago. Drip angles were only put on the slot rails in the valleys.

After the electric roads had been in operation about six months the company decided to put down heavier and higher rails at the curves. Excavations were made between the yokes at all the curves in which cast-iron chairs, weighing about 100 pounds each, were set with concrete packed around them. This work was done in the daytime, and at night after traffic was suspended the old rails were taken up, the rail seats on the yokes broken off, and the new rails put down and secured to the rail chairs. Courses of scoria block are laid on each side of the rails at the curves, the crevices between the bricks being filled with asphaltum.

As a ground return is not used, both the positive and negative feeders are insulated. There are thus twenty lead-covered cables for the ten feeders, each with a cross-section of copper of 1,000,000 circular mils, insulated by saturated paper three-sixteenths of an inch in thickness, and protected by a one-eighth inch lead sheath. They are drawn in through manholes running across the two tracks, spaced at intervals of about 400 feet, one of which is shown in Fig. 2. The knock-down frame for the construction of the concrete walls of one of these manholes is shown in Fig. 11. At points determined by traffic conditions the feeders are tapped in the manholes with two branches from the one splice, as shown in Fig. 14, to the conductor rails, to which they are attached by clamps, one of which is shown in Fig. 16. Those going to the outboard rails pass down through a duct from the handholes to the manhole, as is clearly shown in Fig. 2. One pair of cables is held in reserve as an emergency feeder, being provided with blind taps ready to be cut in at any point from Georgetown to Seventh Street at any time it may be needed. In all there are about 66 miles of cable in place.

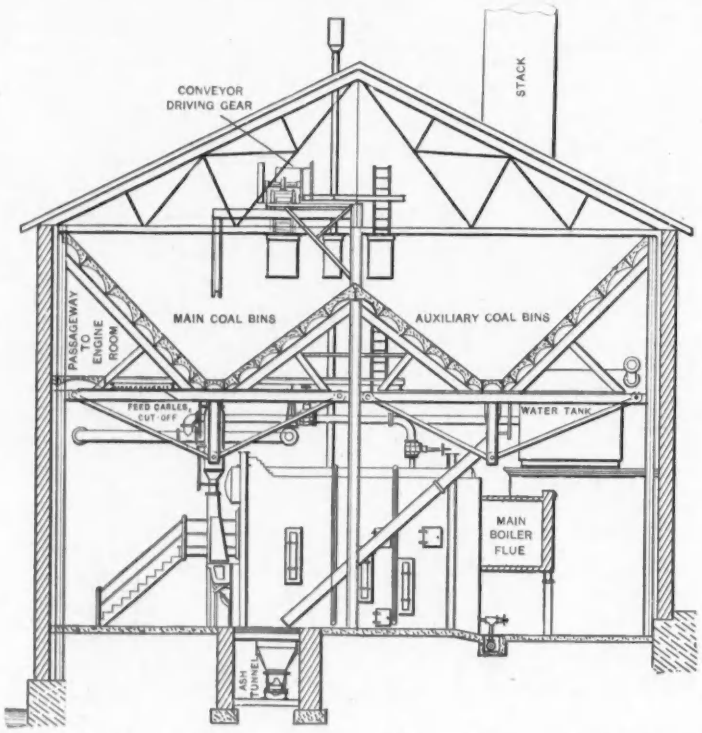


Fig. 6.—A Vertical Section of the Boiler Room and Overhead Coal Bunkers.

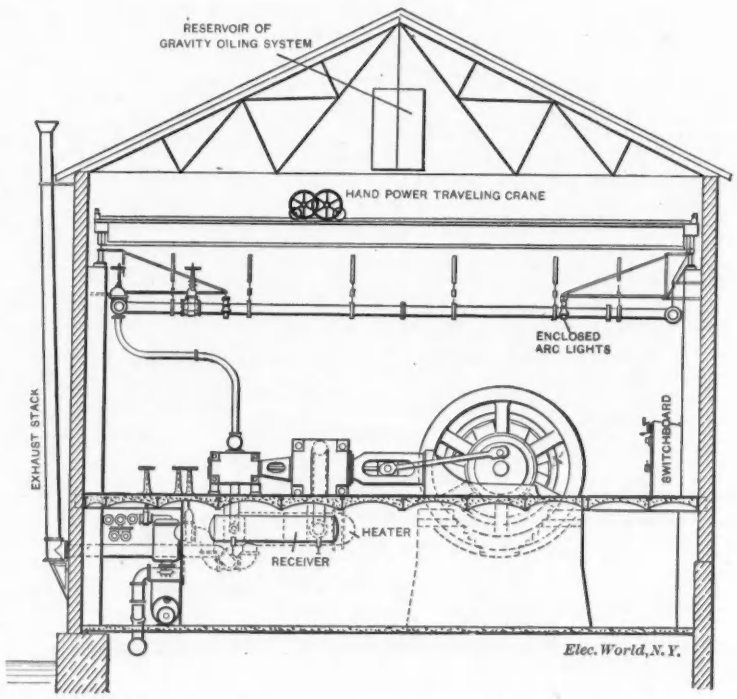


Fig. 7.—A Vertical Section of the Engine Room and Condenser Basement.

THE POWER HOUSE.

The work on the new power house was necessarily very much rushed. There was no year or two for the engineers in charge to look into the relative merits of alternative plans, and they were further hampered by the necessity of using a building which formerly did duty as a feed mill and storage warehouse in the old horse-car times. The work had to be carried on almost while the drawings were being made; nevertheless the plant evidences a surprising amount of ingenious design to overcome the difficulties involved, as will be seen by a study of the description given below. The work was begun about December 1, 1897, and power was on early in April, 1898. The old material was used to a certain extent, the good bricks of the partition walls,which had to be taken down, being used in the engine foundations, the new crane runways being made of the I-beams of the old floors, etc.

The building, a view of which appears in Fig. 12, is located on the edge of the Chesapeake & Ohio Canal, in Georgetown, with Grace Street on the opposite side, between Thirty-second and Thirty-third Streets. It is a long, narrow structure, which did not admit of the standard practice of placing the boilers in a row along one side of a division wall and the engines nearly in a parallel row along the other side. This building required a division midway of its long dimension, one half being the boiler and the other half the engine room. Fortunately, solid rock was but 2 or 3 feet below the basement floor, so that all foundations, even to those of the auxiliary pumps, are carried clear to rock. The old walls, 18 inches in thick ness, are reinforced by pilasters, bonded in and tied to them with anchor rods, the pilasters in the engine room carrying the crane runways. The old wooden roof, covered with slate and supported on combination trusses, has been retained.

FIG. 8.—CAST WELDING THE OLD RAIL JOINTS.

FIG. 9.—DRILLING THE SLOT RAIL FOR THE DRIP ANGLE LIPS.

THE COAL-CONVEYING APPARATUS.

One of the most interesting parts of the equipment is the coal-conveying apparatus. "Run-of-mine" bituminous coal is brought directly to the plant on canal boats, holding about 120 tons each. Standing apart from the main building, toward the west, is the coal-unloading tower of steel-frame construction, covered with corrugated-iron sheathing. (See Fig. 4.) This tower, which shows clearly in Fig. 12, has a boom projecting over the canal, by which tubs holding 1,000 pounds each take the coal up from the canal boats and dump it into a receiving hopper, which, in turn, dumps it into the weighing hopper, Fig. 17, from which it passes down into the crushing equipment shown in Fig. 18. The bucket hoist and crusher are both driven by one 30-horse-power 500-volt motor.

From the crusher the coal is dropped into the buckets of a pan and bucket conveyor. Owing to the novelty and ingenuity of this machine, an extended description may be of interest. The conveyor consists essentially of two 5/8-inch steel cables, to which are clamped, at intervals of a foot, attachments carrying axles, the wheels of which are lubricated with graphite and run on 20-pound steel rails with a 2-foot gauge, each axle carrying a pan and pivoted to it a bucket. An idea of the general arrangement can be obtained by the view shown in Fig. 13, which shows the driving mechanism.

FIG. 10.—BRIDGING AN OLD CABLE VAULT.

FIG. 11.—THE KNOCK-DOWN FRAME OF A DRAW-IN MANHOLE.

This is on the upper horizontal run, the cables in this case being on top of the conveyor, the interlapping pans below fitting closely into each other, the buckets hanging downwardly from them. On the under horizontal run, which is in the ash tunnel below the boilers, the cables (see Fig. 19) are underneath the conveyor, the pans forming over them a continuous trough into which material may be discharged from the hoppers regardless of the position of the buckets, and which protect the cables (the essential driving element) from the material handled. As the conveyor turns up in the vertical run the material is slipped out of the pans into the buckets, which in this position fall against the pans, and when the conveyor turns over from the vertical into the upper horizontal run, the pans swing free with their loads. The driving mechanism, as is shown in the illustration (Fig. 13), consists of a 15-horse-power motor geared down through triple reduction gears to the heavy sprocket wheel, under which run the cables, the clamps on which fit into pockets in the wheel rim, the teeth adjacent to these pockets insuring an absolute drive. The conveyor dumps the coal into W-shaped bins over the boiler room, clearly shown in Fig. 6.

The construction of these bins is most ingenious. They are supported on bar trusses worked in between the steam pipes, resting on columns at the side walls and a row of columns down the centre of the fire room. The bin walls consist of arches sprung between I-beams very much after the fashion of fire-proof floors. The arches are of concrete formed with a flat interior surface on corrugated iron arch plates with a minimum thickness of concrete at the crown of the arch of about 3 inches. This gives a simple construction with a very low depreciation and keeps any corrosive material in the coal from the ironwork. One-half of the W-shaped bins, known as the main bin, is immediately over the fire-room, and from it the coal descends into volume-measuring chutes of 1,000 pounds capacity, which in turn empty through spreaders into the hoppers of the Roney mechanical stokers, with which the boilers are fitted.

These spreaders are shown clearly in Fig. 20, where they are shown swung back from the hoppers. The other half of the into the stokers, but can be delivered through chutes running down, as shown in Fig. 6, to the conveyor in the ash tunnel, which will raise it up again and deliver it into the forward or main bin. Each boiler is fitted with a 100-cubic foot ash hopper in the tunnel through which the conveyor returns, shown in Fig. 19, from which the ashes are elevated by the conveyor into an 800-cubic foot tank

Fig. 13.—The Conveyor Driving Equipment.

Fig 12.—An Exterior View of the Power House.

W-shaped coal bins, which altogether hold 2,000 tons, is filled by overflow from the first half, and is used as an auxiliary or reserve supply to tide the station over the season when the canal is frozen over. The coal does not chute directly from this auxiliary bin in the elevating tower, from which they may be delivered either to canal boats on one side or wagons on the other.

THE BOILERS, FLUES AND STACK.

There are four batteries of boilers in place, laid out as shown on page 720, one battery on the west of the stack and three to the east of it. The space in front of the stack is occupied by filters and the space to the west of the boiler room is reserved for another battery in case increased boiler power is wanted. Each battery consists of two Cahall B. & W.-type boilers, each boiler being nominally of 350 horse-power on the centennial rating. The boilers are fitted with the latest type of Roney mechanical stokers, the detail construction of which is shown in Fig 21, driven by three small Westinghouse engines worm geared to the shafts running across the front of the batteries. In the bottom of the hopper of the conveyor there is located a sliding pusher, to which a reciprocating motion is given by a link driven by the main shaft, the stroke of this motion being limited by a feed wheel. An arm driven by the same link moves the connecting rod, which tilts the grate-bars alternately between a horizontal position and an inclined position, tending to shift the coal gradually down toward the dumping grate. The extent of this motion may be also controlled by a simple adjustment of the nuts on the connecting rod. The steam drums—besides being bricked in—are protected against radiation by 1½ inches of magnabestos covering under the brickwork. Thorough ventilation of the boiler room is obtained through the center passage under the W-shaped bins, which discharges its heated air through a slatted monitor in the roof.

The construction of the back flues is rather interesting, the rear wall being of brick 12 inches in thickness, the top and bottom also of brick, laid between the upturned flanges of inverted T-shaped beams made of cast iron to withstand the considerable heat.

The flues enter the octagonal brickwork base of the stack, a baffle plate preventing their mutual interference. with a pair of twin dampers inserted in each and controlled by Locke damper regulators. The stack foundation is carried down to rock, the stack itself being of steel plate 150 feet in height, with a uniform diameter of 9 feet inside the brick lining. This brick lining is 4½ inches thick

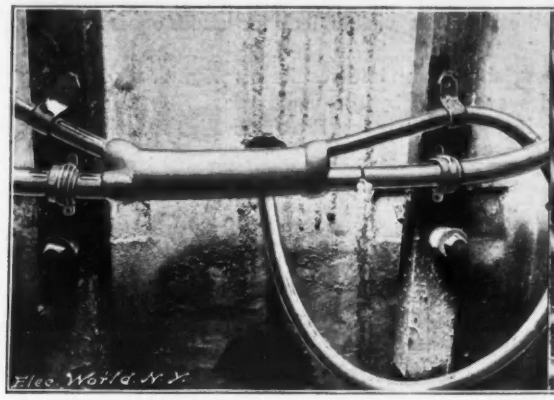


FIG. 14.—THE SPLICE OF THE BRANCHES TO THE FEED CABLES.

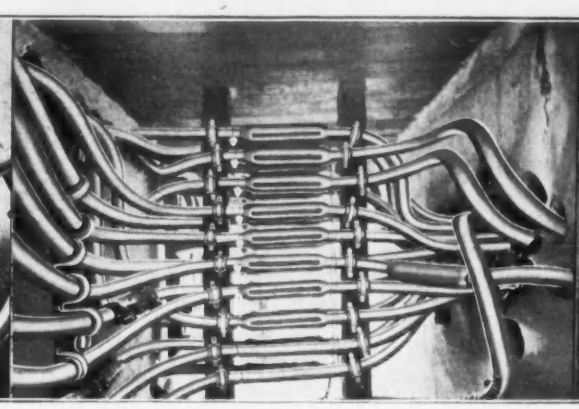


FIG. 15.—THE FEEDER SPLICES.

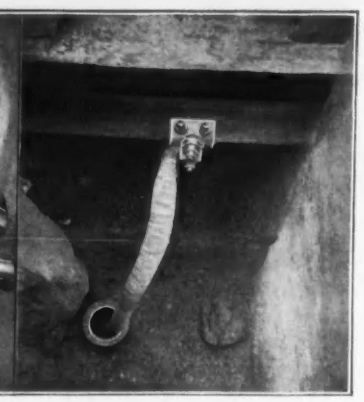


FIG. 16.—THE CONNECTION OF THE FEEDER TO THE CONDUCTOR RAIL.

at the top of the stack, and increases in thickness as the stack tapers outwardly toward its base. The height of stack over all from boiler room floor is about 175 feet.

STEAM AND WATER PIPING.

The piping system of this station has been the subject of unusual study, and is worked out in a very complete manner. Water for boiler feed and condensing purposes is taken from the canal through a 24-inch intake below the ice level, through two screens of half-inch mesh into a concrete settling tank or basin in the engine-room basement. From this five 8-inch pipes with foot valves and strainers rise and run to the five independent jet condensers of the five main units. In this way the condensers cannot interfere with or rob each other, and the choking of any one pipe does not shut down the whole plant. The exhaust of each engine passes first through a Hartford feed water heater and thence through its own jet condenser and its own independent 14-inch exhaust stack of spiral-riveted pipe. Three valve standards on the floor above at the head of each engine control respectively the valves of the steam supply, water supply and exhaust-steam supply of each condenser pump. An automatic atmospheric valve in the pipe running to each exhaust stack is fitted so that when it opens its valve stem projects upward above the floor of the engine room and stays there until forcibly pushed down by the engineer. The arrangement of these details will be more clearly understood by reference to the drawing on page 721.

The feed water is handled by three pumps in one end of the boiler room, one of which, the tank pump, is arranged to lift the water from the well above mentioned to a 4,000-gallon tank over the toilet room to the rear of the boilers. A Mason gravity pump governor controls this pump. The tank may also be supplied from the city mains through a meter at times when the canal is emptied for repairs, and an automatic float valve is installed for control under these circumstances. From the tank the water normally passes to two Loomis-Manning filters, and thence through one of two direct-acting duplex feed pumps, which in turn deliver it through any one or more of the primary heaters attached to the engines and then through the supplementary heater in the boiler room, thence to the feed line and to the boilers. The supplementary heater takes the exhaust of all the auxiliary engines. The whole feed water system is most thoroughly bypassed, as any one or all of the primary heaters or the supplementary heater or the tank or the filters may be cut out, the feed pumps may be used to supply the tank or the boilers direct from the well, the auxiliary exhausts may be bypassed around the supplementary heater, or the condenser pump exhausts may be turned into their own vacuum chambers. Finally, two injectors are installed connected with an entirely independent feed line running along the rear of the boiler steam drums.

The main steam pipe is run on the loop system and is all of extra heavy piping designed for 200 pounds steam pressure, although the pressure at present carried is 140 pounds. The main header is run along one side of the boiler room and continued along the same side of the engine room, and into it all the boilers feed and from it all the engines take steam. This header is 12 inches in diameter, its terminals being connected around to the opposite side of the building, as is clearly shown on pages 720 and 721, to a 10-inch auxiliary main. These two mains are cross-connected near the division wall by an 8-inch equalizing main, giving a sort of figure-8 arrangement. Over the boilers the main header is supported on gas-pipe stands with ball and socket bases to allow for expansion, and at other points it is hung by adjustable rods from brackets and stayed against vibration by sliding attachments to the pilasters. Both the main header and the auxiliary

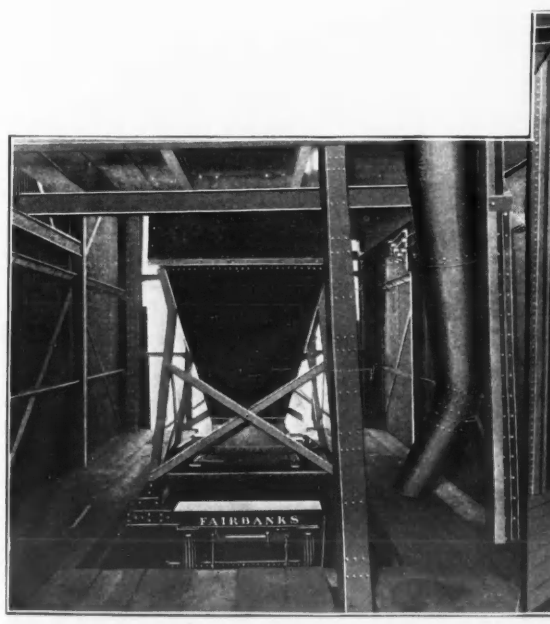


FIG. 17.—THE COAL WEIGHING HOPPER.

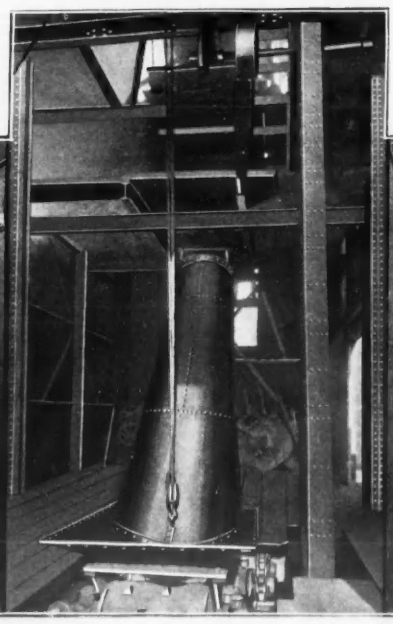


FIG. 18.—THE COAL CRUSHING EQUIPMENT.

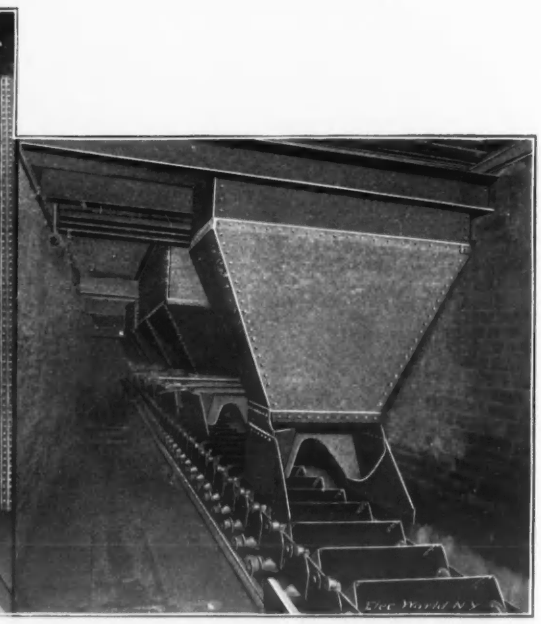


FIG. 19.—THE ASH HOPPERS IN THE TUNNEL.

main are anchored where they pass through the wall between the engine and the boiler rooms, and the expansion—which amounts to a movement of about 3 inches at the extreme ends—is taken up without slip joints or copper bends. This is done by giving each boiler and engine branch a horizontal run with a vertical turn at each end, so joined that the flanges give the proper flexibility. There is a gate valve in the main header between each battery of boilers and between each engine, so that any part of the main can be cut out without shutting down more than one battery or one engine at a time. The cross or equalizing main allows the steam to be fed via any one of several routes, thus giving a surety of operation even with simultaneous accidents to more than one part of the system. Steam for all auxiliaries is taken off from the middle of the equalizing main, which it can reach by either the main header or the auxiliary main. The steam is dried by two separators, one in each of the two steam mains near the points where they pass through the boiler room wall, the entrainment from these separators being returned to the boilers by gravity through the blow-off connections. There are no separators near the engines, and the tees for the engine branches open downward, but there is absolutely no water knocking in the cylinders. The main header has no slope one way or the other, but the auxiliary main slopes from both there being not the slightest visible leak or audible hiss in the whole station.

The oiling system shows also the results of original study. The bearings and slides are oiled by the usual gravity system with a 12-barrel tank up in the roof trusses, shown in Fig. 22, with sight-

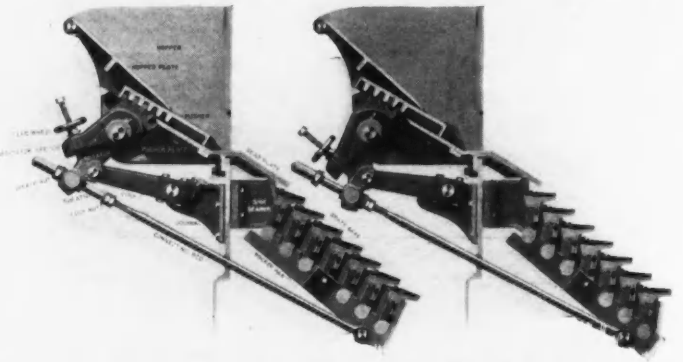


Fig. 21.—Details of Feed and Grate Movement of Mechanical Stoker, with Grate Bars in Inclined and Horizontal Position.

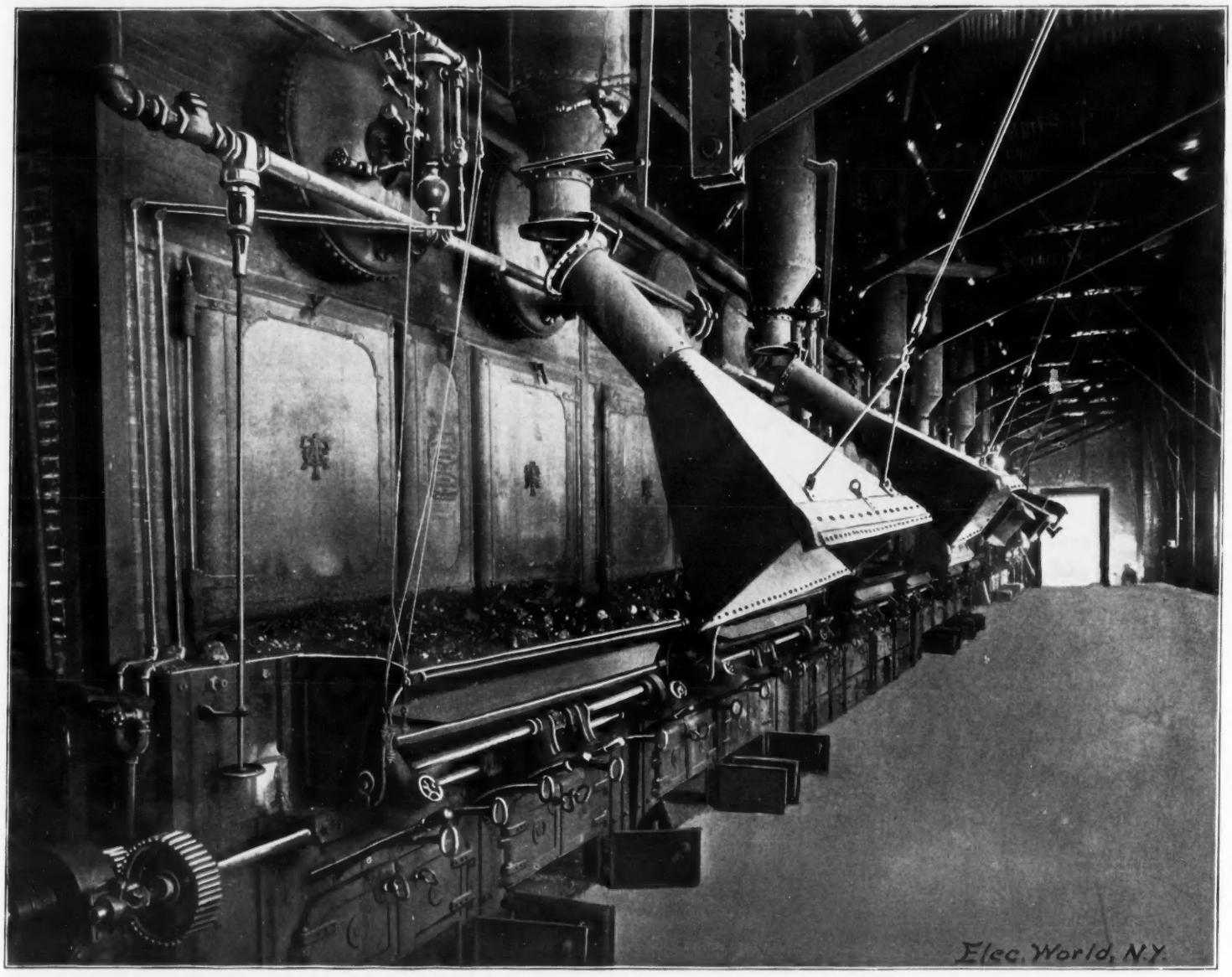


Fig. 20.—The Interior of the Boiler Room.

directions toward its separator. This freedom from water is obtained by means of the two separators above mentioned and by trapping all the engine branches at the stop valve into one Bundy high-pressure trap. All the pressure steam piping is covered with 2 inches of magnabestos, all the joints are kept remarkably tight, feed oil cups; a set of auxiliary glass cups are also kept in reserve. The drips pass through two oil filters in series and thence to a tank in the basement, from which the oil is lifted to the overhead tank from time to time by a steam pump. Oil from the guide drips is separately piped down through a separator, from which it is

drawn to the filters. The cylinder oil is fed under steam pressure by a very ingenious system. A tank holding about one barrel of oil is placed in the basement and piped to the steam header above, the pipe naturally filling with water, which flows into the bottom of the tank and forces the oil floating upon it upward. This is piped to sight-feeders on the engine steam pipes. Two such cylinder-oiling systems, one supplying high-grade oil to the main engines and the other an inferior grade to the cylinders of the auxiliaries, are in use, and a third one is in the boiler room to feed to the pumps and stoker engines. An air compressor of the regular locomotive type is also in service to give compressed air for cleaning the dynamos and switchboard. A constant pressure for this purpose of any desired value is assured by a reducing valve in the steam supply.

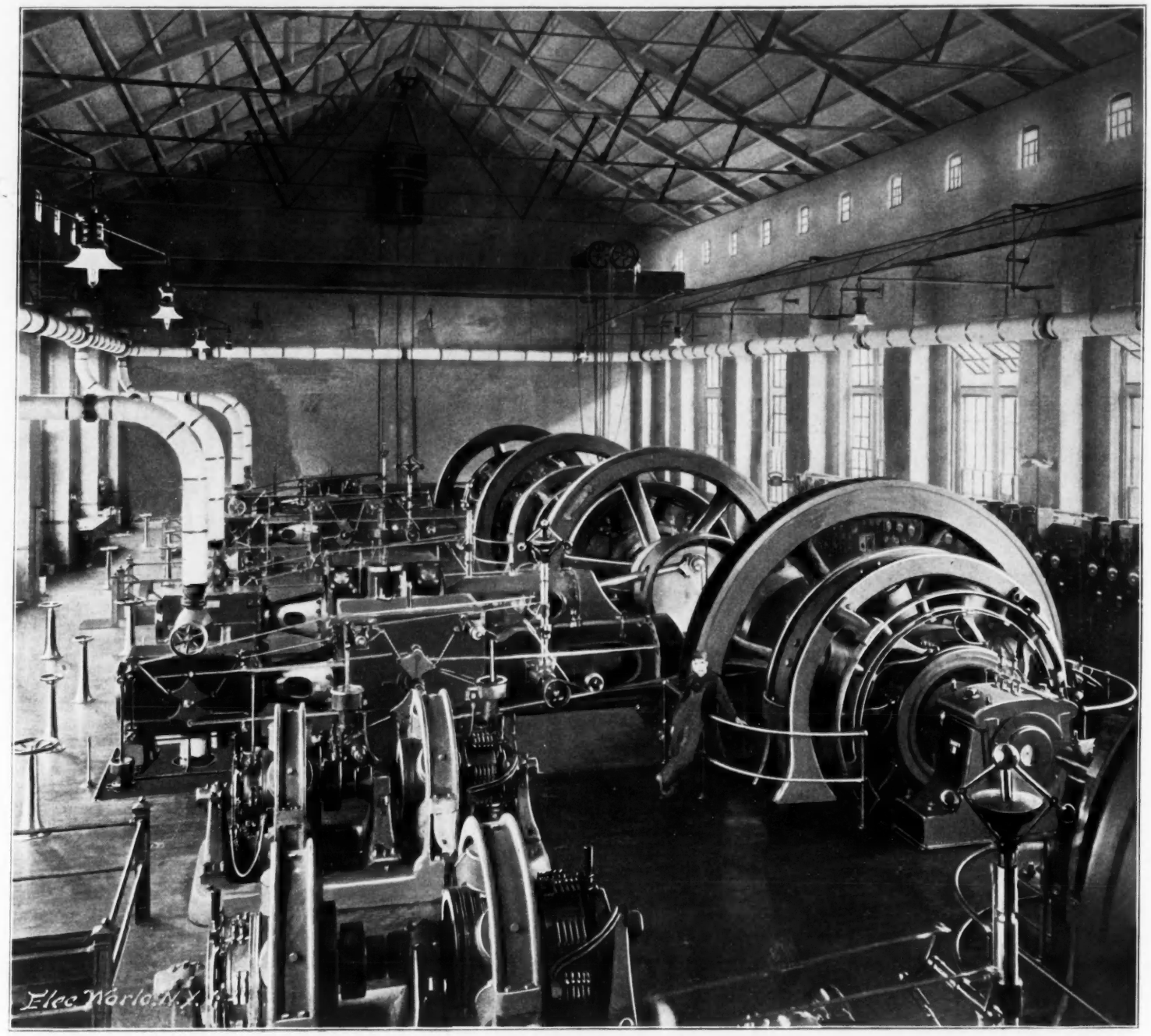


FIG. 22.—THE MAIN ENGINE ROOM.

THE ENGINE ROOM.

The main engine room, shown in Fig. 22, is noticeable for the ample provision of light, owing to the fact that both the long sides are outside walls and well provided with windows. The floor is supported on steel I-beams with concrete arches built on corrugated-iron forms and covered with narrow edge-grain yellow-pine flooring fastened to sleepers bedded in the concrete. A 15-ton hand crane spans the room. The arrangements for lighting at night are unusually complete and ingenious. Ten enclosed arc lights are supported from the craneways on hinged gas-pipe brackets, so that they may be swung in to clear the crane grab or to trim the lamps. These arcs, beside a large number of incandescents and the lighting service of the adjacent shops and the Union Passenger Station nearby, are supplied by a direct-coupled 50-kw 125-volt set, so that light may be had when the railway plant is shut down at night without running one of the large generators. To provide for derangements of this lighting set the incandescent lights are divided, part of them being on series circuits fed from the railway bus-bars and part on the 125-volt lines. All the interior wiring of the lighting circuits is run through loricated steel tubing.

There are five main Allis-Corliss tandem-compound 800-horse-power engines, with the standard and well-known features of this design, the 1890 frame, two wrist plates on each cylinder, raised dash pots on the low-pressure valves, etc. Four of these are arranged in right and left hand pairs on two heavy brick foundations carried down to rock and capped with cast-iron oil pans. Each engine is coupled to a standard 600-volt generator and fitted with a 16-foot 25-ton cast-iron flywheel. Between these engines there are to be three motor-driven boosters, two of which are now installed, each with a capacity of 550 amperes and 180 volts, with a straight characteristic up to 100 volts when running at 600 r. p. m. These are 100-kw 6-pole three-bearing machines with a coupling fitted

snugly under the overhanging barrel winding at the motor end. The dynamo ends are series wound.

The switchboard (see Fig. 23) is of standard General Electric construction with a few peculiarities. The five panels at the left-hand end are standard 1,000-ampere generator panels, with current indicators; the next panel contains two totalizing output instruments, one an 8,000-ammeter and the other a 5,000-ampere integrating wattmeter, and beyond these come the feeder panels, of which two are required for each feeder, one positive and one negative with throw-over switches, by which the polarity of the sections fed may be reversed when desired. This is to provide against a ground on the west rail of one section, for example, and the east rail of another, short-circuiting the buses. By reversing the polarity of either one of the two feeders, the two grounds can be brought on one side of the system and the same can be done with any number of grounds provided no two of them are on opposite sides of one section. On account of the 600 volts difference between adjacent feeder panels, the circuit breakers at the tops are separated by wooden barriers.

The controlling arrangements of the boosters are novel and very interesting. But one motor-starting rheostat is used for all the machines, and this is of the single-switch type illustrated in Fig. 25, the different clips which grasp the knife blade at different positions cutting out the different sections. This is connected in to the line feeding the various motors through a number of double-pole double-throw switches, one for each motor, connected up as shown in the diagram, Fig. 24. Tracing out the lines, it will be seen that any switch thrown up cuts the rheostat in to the corresponding motor and absolutely cuts it out from any of the others. Another interesting detail is the protective device designed to cut the series-wound booster generator out when for any reason the circuit breaker of the motor opens, under which circumstance the generator would tend to run away as a series motor. The circuit breaker of the booster motor is provided with the ordinary tell-tale connected into a battery circuit, which in turn energizes the magnet of a specially designed relay, shown in Fig. 26. This relay, when its magnet is energized, closes the circuit of a fine-wire winding on the booster-generator circuit breaker, which operates the trigger to open the breaker, and immediately thereafter opens the circuit of this same fine-wire winding and also opens the battery circuit to prevent waste of battery power. This does not connect the boosted feeders over onto the bus bars, but leaves them on open circuit. There are two long feeders for which the boosters are intended, the board being so arranged that each of these feeders may be thrown in series with its own booster, the third booster being arranged to be thrown on either of the two feeders, or either feeder may be thrown directly to the 600-volt bus. At the right-hand end of the board, the next to the last panel is fitted with a water rheostat, which may be connected between either bus and ground, its purpose being to burn out grounds on the line by a current which may be thrown on through and adjusted by means of the water rheostat. The last panel controls the auxiliary motors and 600-volt lighting lines.

Fig. 23.—The Front of the Switchboard.

THE ROLLING STOCK.

About sixty motor cars are run, and both trucks and bodies are new. Short cars with bodies only 18 feet long are used, and run with trailers. The plow, an idea of which can be obtained from Figs. 5 and 27, consists of the usual steel plate enclosing copper straps and running down through the ¾-inch slot with an enlarged

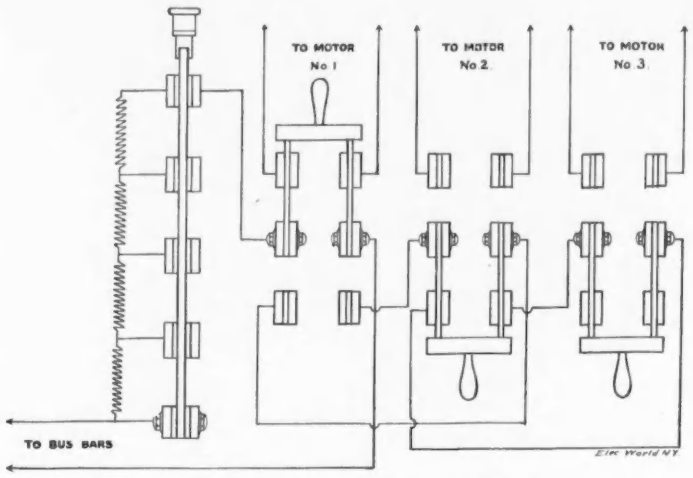


FIG. 24.—THE STARTING RHEOSTAT CONNECTIONS.

wooden section carrying on outward-bearing springs the cast-iron shoes. The shoes are beveled at the ends to prevent their catching on the joints in conductor bars and on parts of the switch gear. The plow-hanger in the truck is ingeniously arranged so that in case of derailment or a misplaced switch the plow will fall off after traveling part way across to the side frames of the truck, and drop into the conduit sufficiently to clear the motors. This prevents, in case of such an accident, the plow from becoming wedged and twisted in the slot, which requires its cutting out by cold chisels and the shutting down of the line for some time.

THE PERSONNEL.

Those in charge of the work and to whom credit is due for many of the ingenious improvements and modifications designed for the special problems involved are as follows: The work was in general charge of Mr. D. S. Carll, chief engineer and superintendent of

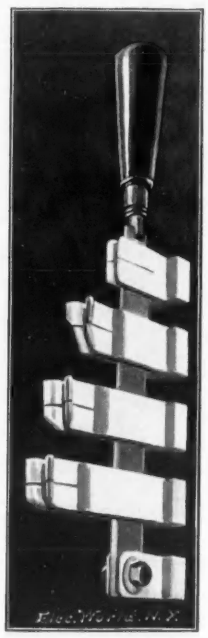


FIG. 25.—THE BOOSTER STARTING RHEOSTAT.

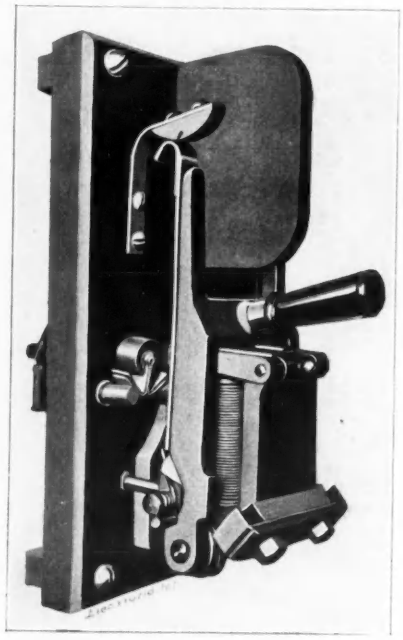


FIG. 26.—THE BOOSTER CUT-OUT RELAY.

the company, who was assisted by W. B. Upton, the principal assistant engineer; the special tools for track work were designed by Mr. H. P. Clarke, master mechanic,and M. E. Safton, the contractor. Mr. J. H. Hanna, assistant superintendent, has charge of the electrical work, and Mr. Carroll Hoshall is the chief engineer of the power station. The consulting electrical engineer was Dr. Louis Duncan.

The Building Committee having in charge the reconstruction of the road consisted of Mr. George T. Dunlop, president of the Capital Traction Company; Mr. Henry Hart and Mr. Samuel F. Phillips.

The concerns supplying various parts of the equipment and contracting for stated portions of the work were as follows:

Street and track work, E. Saxton.
Iron work for power house, Structural Iron Company.
Boilers, The Aultman & Taylor Machinery Company.
Stack, The Campbell & Zell Company.
Water filters, The Loomis-Manning Filter Company.
Pumps and condensers, The Deane Steam Pump Company.
All valves, The Chapman Valve Manufacturing Company.
Steam piping, Thos. C. Basshor & Co.

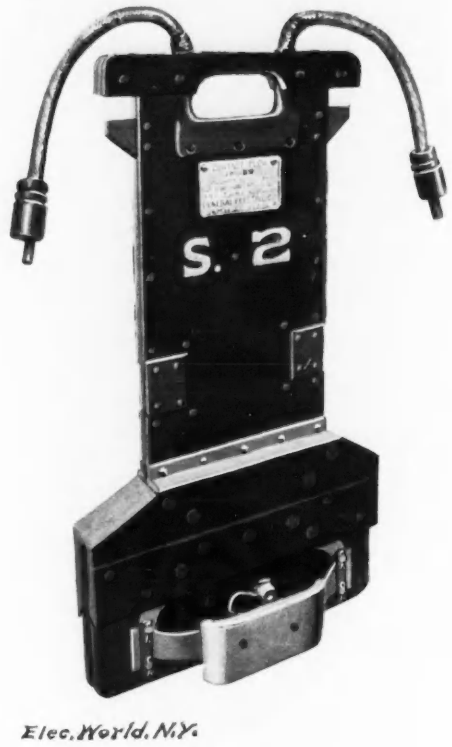


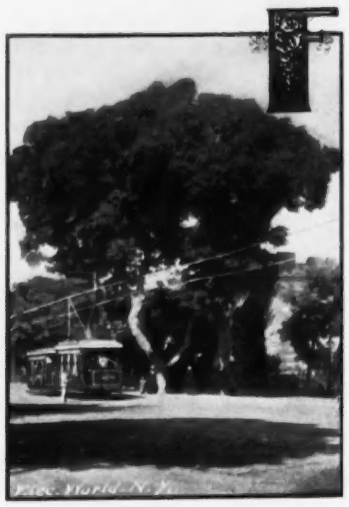
FIG. 27.—A VIEW OF THE PLOW.

Covering, The Keasbey and Matteson Company.
Stokers, Westinghouse, Church, Kerr & Co.
Coal conveyor, The Steel Cable Engineering Company.
Engines, The E. P. Allis Company.
Dynamos, switchboard, boosters, car motors and controllers, enclosed arcs, General Electric Company.
Auxiliary motors, The Westinghouse Electric & Manufacturing Company.
Trucks, The Baltimore Car Wheel Company.
Car bodies, The American Car Company.
Vitrified clay pipe, The H. P. Camp Company and the Potomac Terra Cotta Company.
Wrought-iron cement-lined pipe, The National Conduit & Cable Company.
Heaters, I. B. Davis & Son.
Underground feeder cables, The John A. Roebling's Sons Company.
Cast welding of the joints, The Falk Manufacturing Company.

Another Electrical Conduit System in Washington.

Another cable road in Washington will be transformed into an open conduit system. The Columbia Railway of that city, notwithstanding the fact that it has a modern cable plant in perfect running order, will follow the example of the Capital Traction Company, described above, and install electrical conductors in its cable conduits.

Electric Street Railroads in Cairo, Egypt.



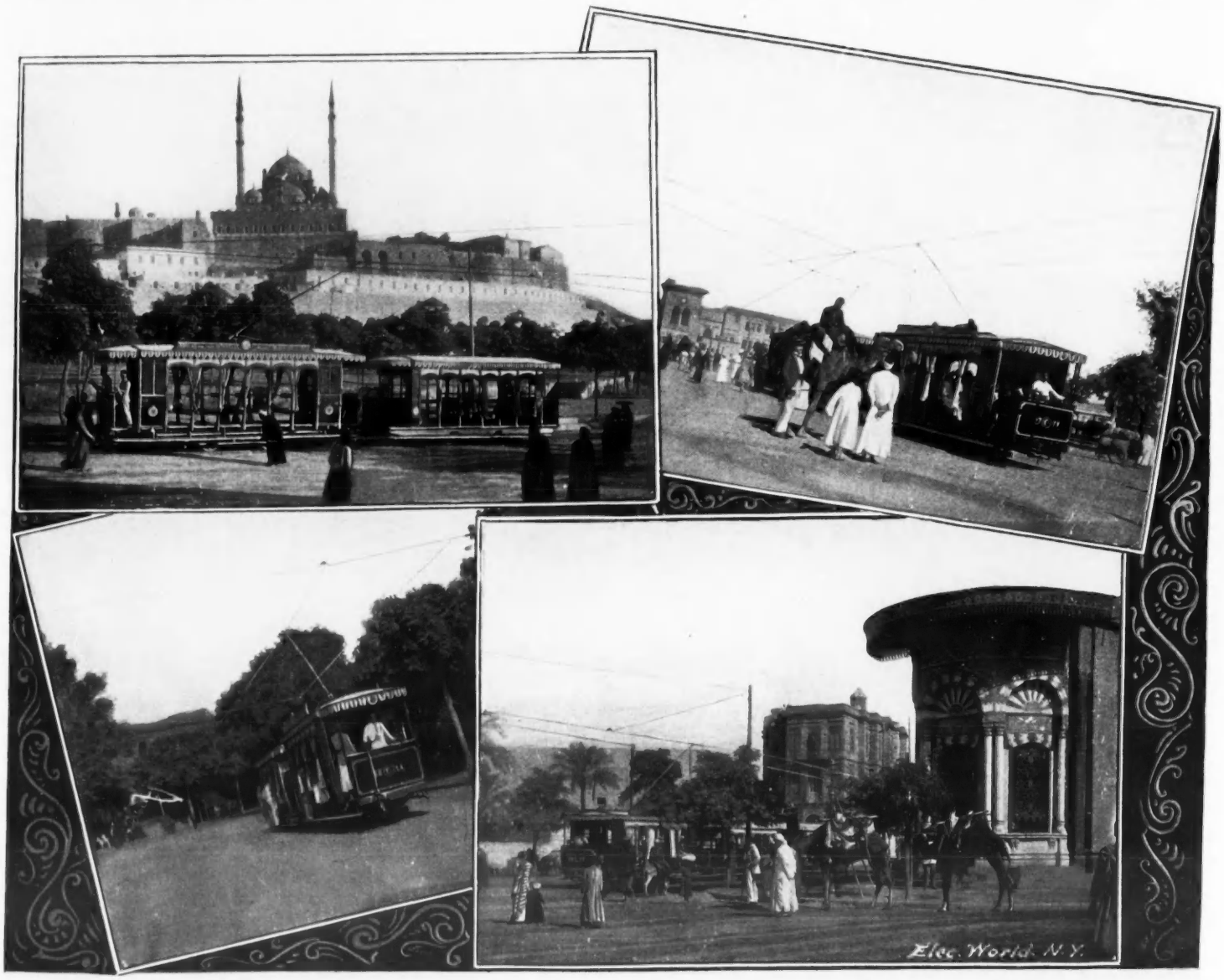
FORTY centuries, declared Bonaparte in 1798, looked down from the pyramids upon the victorious armies of the French Republic in Egypt. Forty centuries and one now look down from them upon an innovation in the very home of orientalism, of greater importance to the Egyptian people than even the great French incursion—an innovation which transplants into that old-world country one of the civilizing influences of the very youngest nation—the American trolley car. The cars themselves, as well as certain other portions of the equipment, may not have been built here, but the system is American, and Sprague, Vandepoele and Edison have as much contributed to the wholesale toting of Arabs in Cairo, as to the transportation of the intellectual Bostonians in the "Hub."

In December, 1894, a Belgian syndicate secured from the Egyptian Government a concession for the equipment of the streets of Cairo with electric traction, and a company was formed for the purpose of constructing the road. None of the shares are held in Egypt. The road is entirely owned by foreigners, and the shares are already worth nearly, if not quite double their par value.

The lines so far completed are ten in number, having a total length of 23 kilometers, or somewhat over 14 miles, of which ten miles are laid in double track and four in single track with a gauge of one meter.

The power station, built upon substantial European lines, is located at the mouth of the Ismailia Canal, near the Nile. The equipment of the boiler-room consists of three Cornish boilers, each of 400-hp. capacity, provided with fuel economizers. Steam at 150 pounds pressure is supplied to three horizontal tandem-compound condensing Sulzer engines, running at 120 r.p.m. The high pressure cyclinders of these engines are nearest the crossheads, and the valves of all are driven by a shaft running parallel with the piston rod and actuated from the main shaft through mitre gears. The exhaust valves are below the cylinders and the steam valves of the lift type above. All the exhaust valves are actuated by eccentrics on this auxiliary shaft, the steam valves on the low-pressure cylinder are driven by cams, and those on the high-pressure cylinder by eccentrics with a detaching device with a drop and dashpot, the trip being controlled by a governor, as in Corliss engines. The cylinders are oiled by small force pumps driven by the valve shaft. The water for the boilers and condensers is pumped directly from the Nile by electrically driven centrifugal pumps. Room has been left in the engine room for five electrical steam units, the additional two to be added as traffic warrants. A travelling crane runs the length of the engine room.

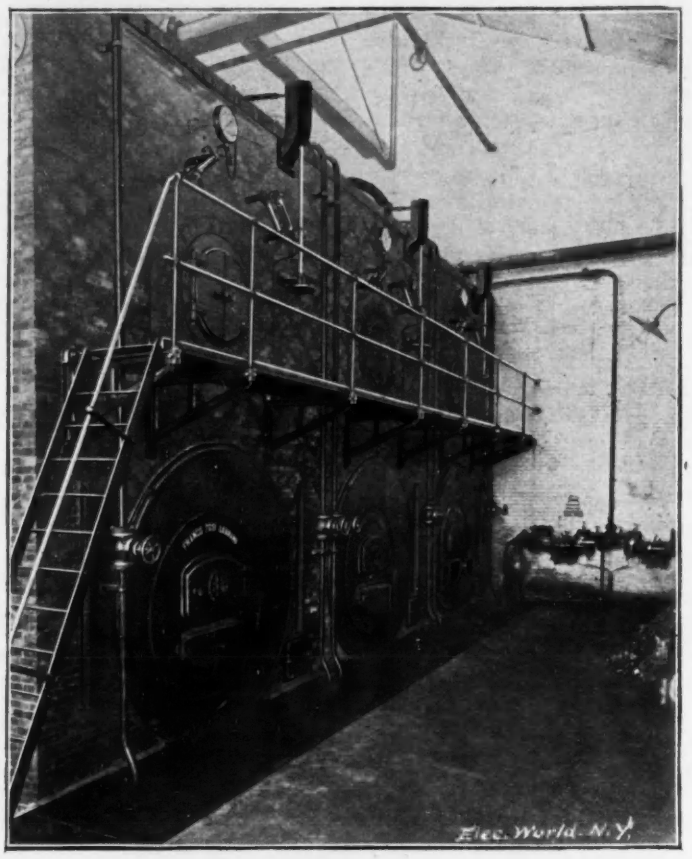
The overhead line is suspended from span wires, which in the city streets are stretched between wrought iron poles or from ornamental wall plates fixed to the sides of the houses. Outside the city the span wires are suspended from impregnated wooden poles. At the Kasr-el-Nil bridge, which at certain fixed hours of the day is open to allow the Nile boats, with their tall single masts, to pass



Street Scenes in Cairo, Egypt, Illustrating the Old and the New Methods of Transportation.

through, the feeder cable for the Pyramid section is laid at the bottom of the river. The overhead line apparatus is similar to that used in this country.

The rolling stock consists at present of forty motor cars and twenty trailers, although more have been contracted for. Each motor car is equipped with two G. E. 800 motors, adapted for the metre gauge, and two series parallel controllers of the K type. Each motor car is capable of hauling two trailers. All the cars were built in Belgium, and carry on both sides of the roof signs in both French and Arabic giving the route of the car, and on the dashboard its number, with the crescent dividing the European from the Oriental numerals. As the climatic conditions in Cairo are of the mildest, no closed cars are necessary; all are open. They are divided into two classes, one for Europeans and one for natives, and the back seat is reserved for the harem women. Side curtains are provided, but are never drawn, and there is no curtain to divide the harem portion from the rest of the car. On an important route the "ceaseless chatter of its black-cloaked, black-veiled occupants, regardless of the silk-robed men in front and the red night-capped hangers on at the sides, gives an hysteric suggestion of a picnic attended by masked mourners."

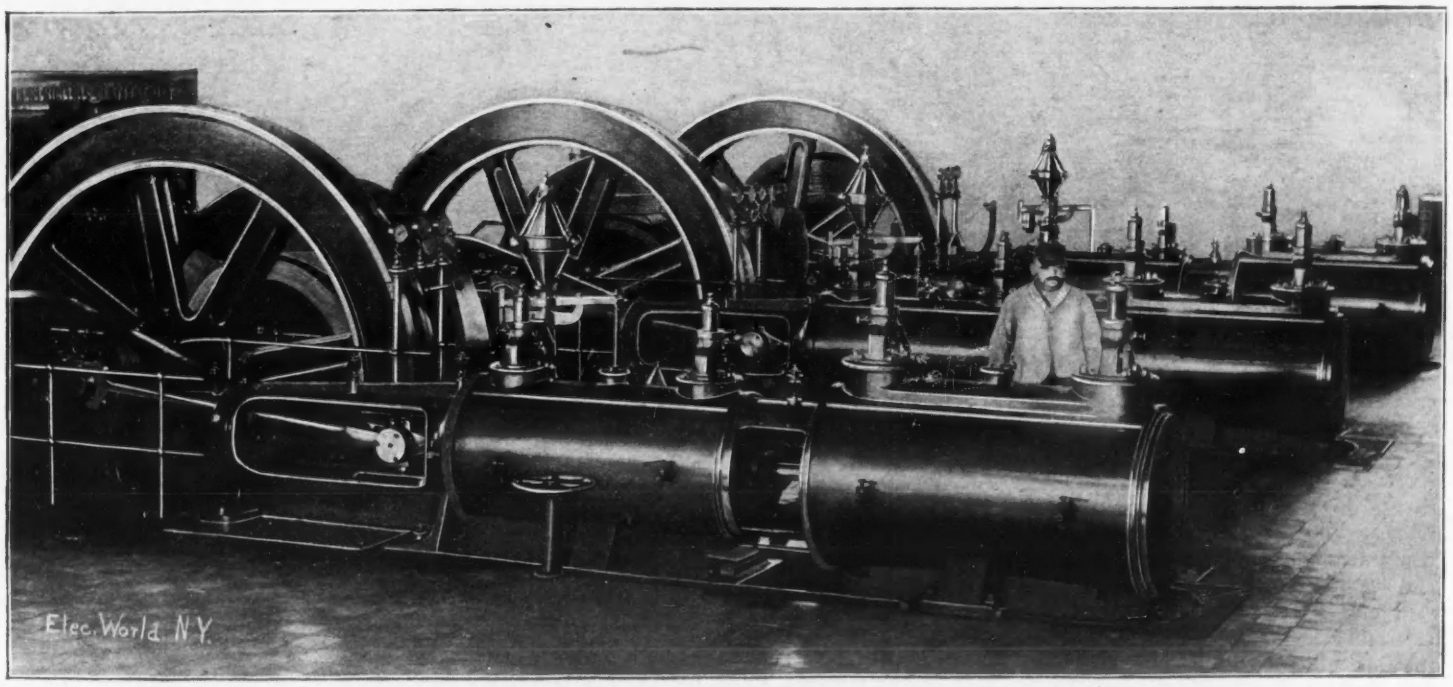


A VIEW IN THE FIRE ROOM.

The new system of rapid transit inaugurated August, 1896, is extremely popular, as much with the native population as with the European. The road by no means runs only through the better, or the European, quarters; and the native man, woman and child finds the electric car a distinct improvement on the camel, the frowzy hack, the donkey, or walking. The speed of the cars is 10 kilometres, or about 6.2 miles, per hour. The conservatism of the Arab asserted itself to some extent at first, but only to his serious detriment. It took him some time to seize the inwardness of the warning sound of the gong and occasionally he has paid for his slowness with his life. An extension of the system in a single track as far as the Pyramids is now under construction and rapidly nearing completion. Indeed, by the time this is printed the excursion that has been made from time immemorial on the back of a small ass, pursued by a relentless small boy, is, perhaps, being made in a regulation trolley car. The distance covered by the new line is about 7 miles. It will follow the famous road to the Pyramids, from the head of the Kasr-el-Nil Bridge, crossing the two arms of the Nile, down left bank of river to Ghizeh, then due west to the Mena House, the hotel of the Pyramids.

Where the Pyramid line comes up to the Nile bank, a ferry communicating with the electric tramway terminus directly opposite in Cairo will be established, saving 3 miles' ride by way of the bridges for those who may not desire to ride from or to the Kasr-el-Nil bridge.

The road is operated by the Société Anonyme des Tramways du Cairo, under the general management of Mr. Jules Borel. The electrical equipment was furnished by the Union Electricitäts Gesellschaft, of Berlin.



THE THREE MAIN GENERATING UNITS.

The Customs Tariff of Japan.

On January 1, 1899, the new customs tariff of Japan will take effect. According to its provisions, as set forth in a pamphlet just published by the Japan-American Commercial and Industrial Association of New York, the following articles of an electrical character will be subject to import duty at the rates specified: Electric light apparatus or instruments and parts thereof, 10 per cent. ad valorem; telephone and parts thereof, 10 per cent.; wire, telegraph or galvanized, 10 per cent.; mica in sheets, 10 per cent.; submarine telegraph cables and underground telegraph cables, 10 per cent.

The Recent Street-Railway Franchise Struggle in Chicago.

Since the famous Jake Sharpe case in New York never has a city been more thoroughly stirred up over a street-railroad matter than Chicago has been for the past three weeks. On Monday, Dec. 5, an ordinance providing a fifty-year extension of the operating rights on the principal systems was introduced into the City Council and referred to the Joint Committee on Streets and Alleys, North, West and South. Since that time a lively fight has been in progress, in which the mayor, newspapers, aldermen, traction companies and the public have all had a hand.

The ordinance which began the excitement in Chicago was designed to take advantage before any possible repeal of the new Allen State law permitting street-railroad franchise grants of fifty years in length. It provided that the ordinances in existence giving privileges to the North Chicago Street Railroad Company, the West Chicago Street Railroad Company, the Chicago City Railway Company, the Chicago General Railway Company and their allied lines should be extended for fifty years in consideration of a certain amount of compensation to be paid to the city by the companies in excess of all existing obligations and burdens. This compensation was to be figured on a basis of gross receipts divided by miles of track, and was to start at 3 per cent. for the North Chicago and Chicago city companies, and 2 per cent. for the West Chicago Company. The total extra return which the city would probably have received in the fifty years under this ordinance is approximately $75,000,000.

The Street and Alleys Committee, to whom the ordinance was referred, had daily meetings during the week following the introduction of this ordinance, at which the presidents of the principal street railroad companies and representatives of the public spoke. A subcommittee was appointed to examine the books of the companies and ascertain whether the compensation offered to the city was fair. At the next Council meeting, December 12, however, the ordinance was taken from the Streets and Alleys Committee and referred to the Committee on Railroads. The sub-committee of the Streets and Alleys Committee continued its sessions, believing that a substitute street-railroad ordinance introduced at the first meeting was before it. This sub-committee completed its labors by drafting a new ordinance, which was adopted by the entire Streets and Alleys Committee, and was scheduled for presentation to the Council on December 19.

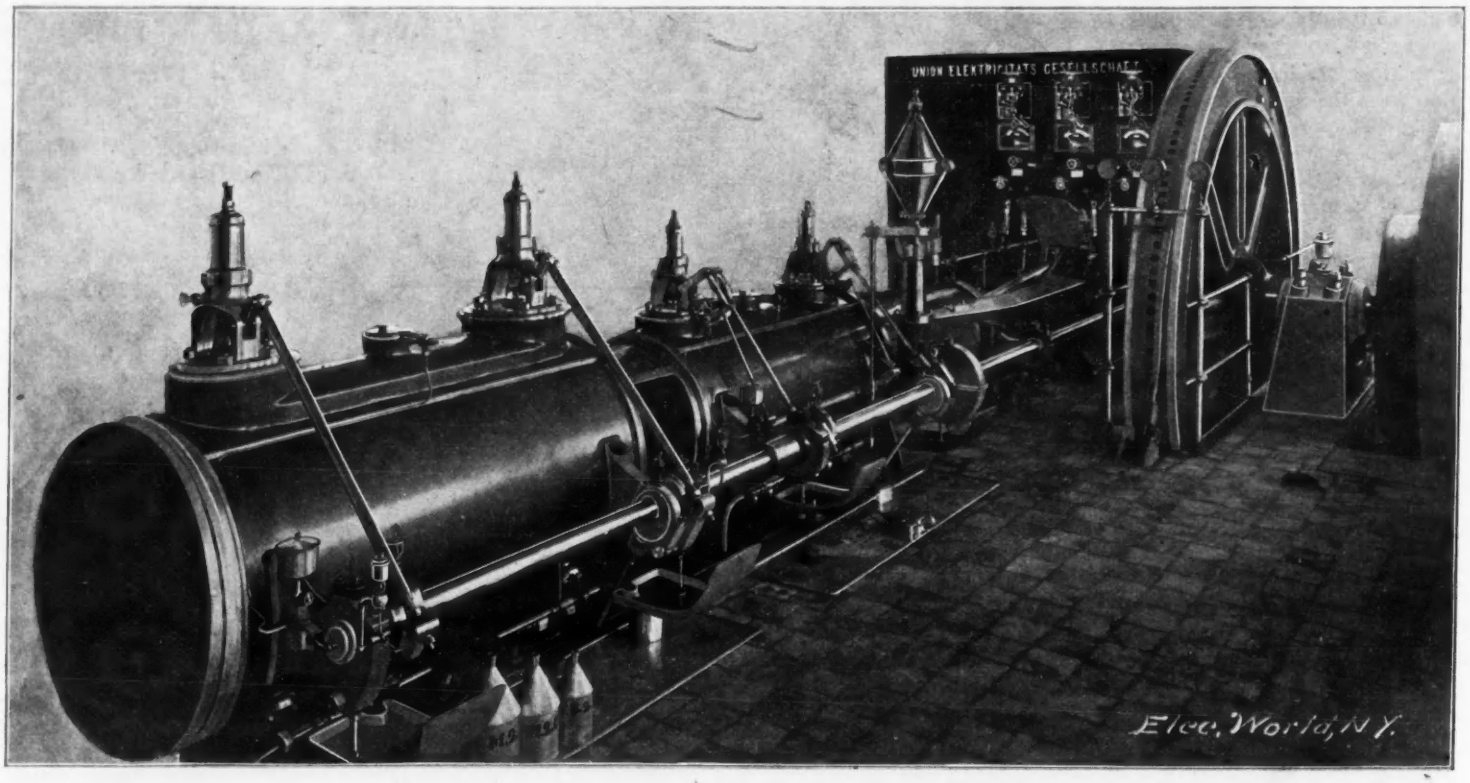
This substitute ordinance was prepared as a popular measure. It provided that the existing ordinances of street-railway companies should be extended until 1930. In return the companies were to pave from curb to curb all streets on which they had tracks. This was to be done within five years. After the first ten years the companies were to pay to the city for the succeeding decade 3 per cent. of their gross receipts; during the next following five years, 4 per cent., and for the remainder of the life of the franchise, 5 per cent. For the first twenty years 5 cents was to be the fare, with six tickets sold for a quarter, good during the hours between 6:30 and 8 o'clock in the morning, and 4:30 to 6 o'clock in the afternoon. One free transfer was to be given with each ride. A further clause was inserted providing for municipal ownership at the expiration of the term set in the ordinance.

In spite of this advantageous bargain offered to the public, however, the mayor and his supporters overruled the measure. The whole subject, with all pending ordinances and amendments, was referred by a majority of one vote to the committee on City Hall. This action has apparently settled the matter for the time being as far as the City Council is concerned. It is now supposed the street railroad companies will apply to the next session of the Illinois Legislature for a law granting the extensions they could not secure from the Council.

The inside motives which have led several of the newspapers, backed by Mayor Harrison, to foster the agitation against the ordinance are stated to be a desire to secure blackmail and chagrin at the failure to do so. President Charles T. Yerkes, of the North and West Chicago street railroad companies, represented this plainly in a statement he made two weeks ago to the New York "Journal." This statement has been published daily in the "Inter-Ocean" ever since, but has gone unchallenged as yet. It reads, in part, as follows:

"The officers of the street-car companies have done everything in their power to bring about a proper understanding between the city authorities and their companies, but owing to the action taken by some of the newspapers in Chicago the efforts, up to the present time, have been of no avail.

"The fact is that there is a combination of newspapers in Chicago which levy blackmail on any corporation which they can force to pay tribute. The Chicago 'Tribune,' the Chicago 'Record' and the 'Daily News' are conspicuous in this business. The proprietors of those papers have agents who make demands on the corporations. Demands have been made on the traction companies, which have been refused, and which will continue to be refused.



One of the Engines of the Cairo Electric Railway Plant.

"I know what I am saying when I give you these facts, and know that what I say to you is libelous and I am liable to an action for slander. I wish to say that I defy the proprietors of those papers to bring such an action against me, and there is nothing which would please me more than to have them do so and give me an opportunity to appear in court and expose their nefarious schemes.

"It is also a fact that there has been an arrangement made between these newspaper people and Mayor Harrison, to the effect that if he will prevent the traction companies from obtaining the extension ordinance, they will favor him for mayor at the next election, and also for Governor in 1900. This whole excitement is brought about for the purpose of driving the traction companies to settle with these blackmailing newspapers.

(Signed) "CHARLES T. YERKES."

The Use of Gas Engines for Dynamo Driving.

BY JOHN C. KELLEY.

I have often been asked why it is that gas, gasoline and oil engines are more largely used in England than in this country. For this condition of affairs various reasons may be given, the most obvious, perhaps, being that illuminating gas of, say, 700 heat units value costs about twice as much here as in England. For example, in Manchester, England, such gas costs about 60 cents per thousand cubic feet, while in New York City the present rate is $1.15 per thousand cubic feet. The result is that when any comparison of cost per horse-power hour is made with an economical type of steam engine the figure, 2 cents per horse-power hour, obtained with a gas engine of good design, is much less favorable to the gas engine than its thermic efficiency entitles it to be for engines larger than, say, 40 or 50 horse-power.

If, however, the rates for gas were to be reduced 50 per cent., as I believe might be done when used in large quantities for fuel purposes, the gas engine, even in small sizes, would give power at a cost of 1 cent per horse-power hour, and thus compare very favorably with the steam engine and give a wonderful impetus to the gas-engine business.

In this connection, I might say that in Boston it has recently (October 29, 1898,) been arranged by the Brookline Gas Light Company with the city of Boston to reduce the price of gas for fuel purposes to 75 cents per 1000 cubic feet, and to make graded prices for gas used for power purposes in gas engines, so that they will be for engines up to 100 horse-power 1 1-5 cents per horse-power hour, in gas engines from 100 to 200 horse-power 1 1-10 cents per horse-power hour, and in engines of 200 horse-power and upward 1 cent per horse-power hour. These prices, which are understood to take effect early in the spring when the Massachusetts Pipe Line Gas Company will have completed its immense plant at Everett and will supply by contract coal gas of 18 candle power to the Brookline Company, will at once place gas engines according to size on an equality with steam engines using five to six pounds of coal per horse-power hour, which fairly represents the coal consumption usually met with in steam engines of moderate size working under variable load.

In England not only is illuminating gas lower in price, but there is a much more general use made of producer gas to operate gas engines, even for powers as small as 20 horse-power for factory and other service. Nothing corresponding to this is done here, except that for large powers, say, 100 horse-power and upward, a few gas producers are being installed for power stations and like service. Such engines compete in economy with our highest grades of steam engines.

But though progress is still slow, such plants will be widely used when once the fact is generally appreciated in this country as it is in England that a pound of coal gives far more power when made into gas and run through a gas engine than if burned under a boiler to generate steam for a steam engine. That the cost of fuel is almost a controlling factor in the question of installing gas engines is shown by the fact that the demand for large engines suited to our natural gas regions is steadily increasing.

As regards gasoline engines, improvements in the details, and particularly in the electric igniter, have placed this motor in position to compete with high-grade steam engines, yielding as it does power at a cost of ¾ to 1 cent per horse-power hour. The underwriters' requirements, however, restrict the gasoline engine to localities where there is sufficient space available to place the gasoline storage tank 30 feet away from any building. But for country houses and hotels, village water works, factories or lighting stations, the gasoline engine seems just what the conditions demand, and there are a number of engines in use for such service, besides others to operate dynamos to charge storage batteries. The demand for gasoline engines is growing for out-of-town power plants, especially in the larger sizes for electric lighting and factory service.

The lessened sales over former years of the small sizes of gas engines, say, 5 horse-power and under, is, perhaps, due also in great measure to the competition of the electric motor. A small gas engine cannot be sold for the same price as a small motor, because it is a much more difficult and expensive machine to build. But it is found, as a rule, that those who install such machinery consider only the first cost and do not consider at all the cost of operating, which is a matter of vital importance. For example, a 3-hp electric motor may be bought for, approximately, one-half what a first-class 3-hp gas engine will cast. (The motor, it may be remarked, will weigh about 450 pounds, while the gas engine weighs about 1500 pounds.) The difference in price may be, say, $150, while the difference in cost of operating may be, as shown by actual examples, as much as $200 to $240 per year, or nearly enough to pay for a gas engine the first year. In fact, careful comparison of costs of operating gas engines and motors doing the same or equivalent work has shown the motor to cost from two to three times as much to operate as a gas engine.

Were this item of cost based on actual charges for street current more generally known, instead of there being in New York City about ten times as many small motors as gas engines in service, the proportion might be reversed. Abroad the cost of operating is considered very carefully, and first cost in its due proportion, which may account, in part, for gas engines being used so much more largely than here.

As regards the application of gas engines to isolated electric lighting, a few instances may be cited. The direct-connected plant of 500-lights capacity installed at the house of the American Society of Civil Engineers, 220 West Fifty-seventh Street, has been in service nearly a year, and has proved satisfactory, the cost for fuel and attendance being about one-half that of street current, and the quality of light and regulation being excellent.

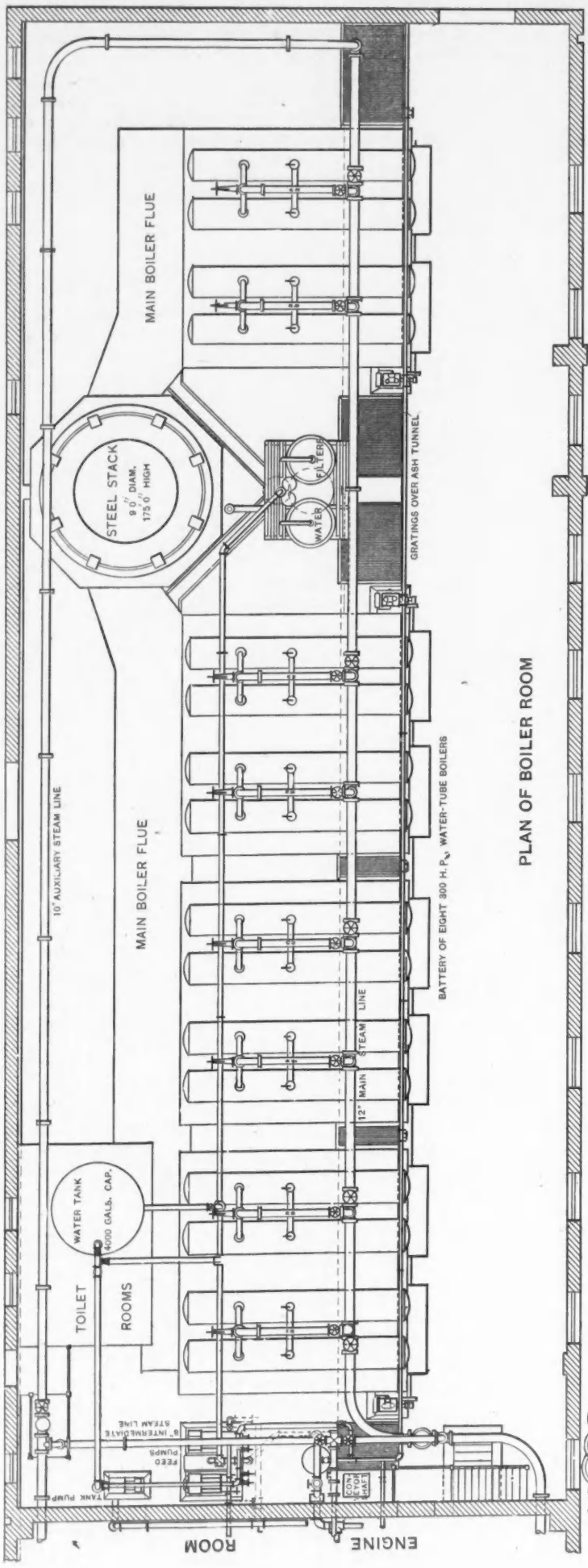
The two-cylinder Nash engine gives two impulses on the crank shaft every two revolutions, instead of only one as in the single cylinder engine, and the governor is so sensitive that it automatically regulates the speed to within 2 per cent. from full load to no load. Besides this, a special coupling, which connects the engine and dynamo, is so adjusted that it is impossible for the speed of dynamo to vary but very slightly either way from normal speed before it is corrected by the coupling and the governor acting jointly. Regulation, in fact, is so close that the voltmeter shows less than one volt variation under changing loads.

At the civil engineer's house they installed a low-pressure steam heating apparatus for warming the building, while gas engines are used only for the electric lighting. Some of our steam heating engineers were disposed to question the wisdom of this arrangement as compared with a steam lighting plant and steam for heating, but the result, in this case, has justified the choice and shown the economy of departing from standard practice which has compelled the use of a steam plant, oftentimes, solely because it provided exhaust steam for heating, and because it was thought no matter how wasteful the steam engine might be, it cost nothing for the steam heating.

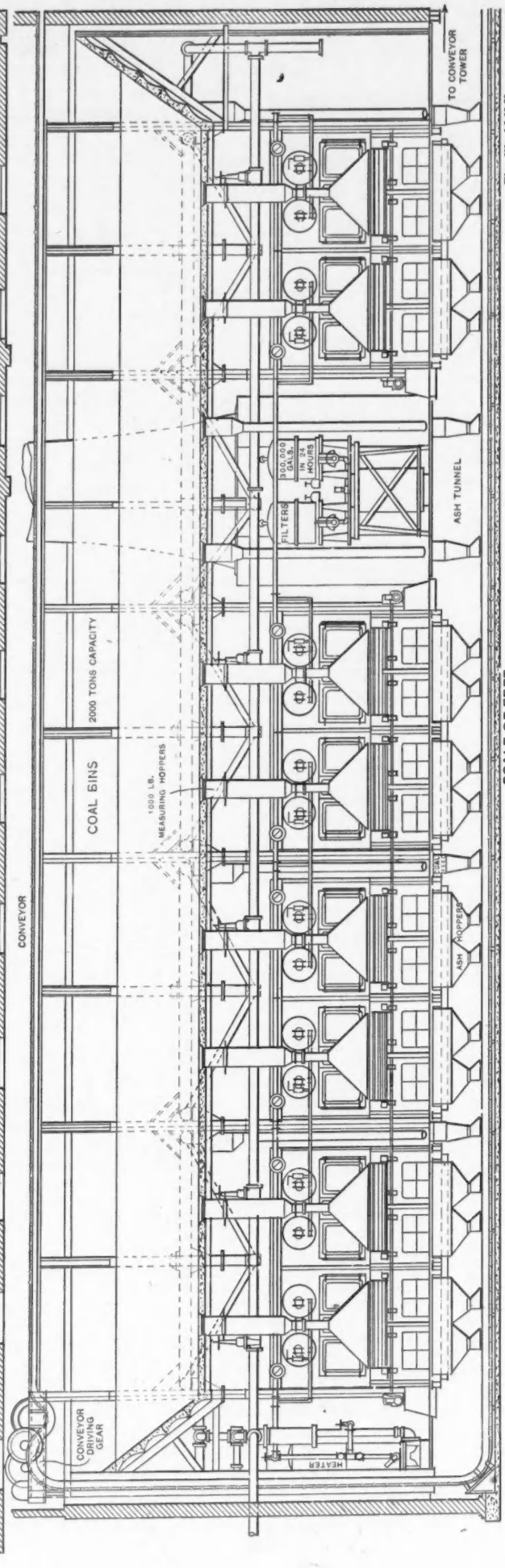
The gasoline engine, particularly, which places country houses in an even more favorable position than those in the city with respect to electric lighting at a very moderate figure, I regard as especially promising. What we need just now is more intelligent appreciation, on the part of architects and owners, of what constitutes first-class gas engine machinery and willingness to pay a fair price for it. The market is flooded with cheap gas engines, as it is with cheap steam engines; but while it is recognized that the severe requirements of electric lighting have wonderfully developed the steam engine, and that nothing but the very best engines will serve, it does not seem yet generally appreciated that in like manner only a high-grade gas engine will answer for electric lighting.

An Automobile Issue.

The English technical journal, "Industries and Iron," devoted its issue of November 25 to the subject of automobile motor cars, describing and illustrating among other classes many interesting electrical vehicles.

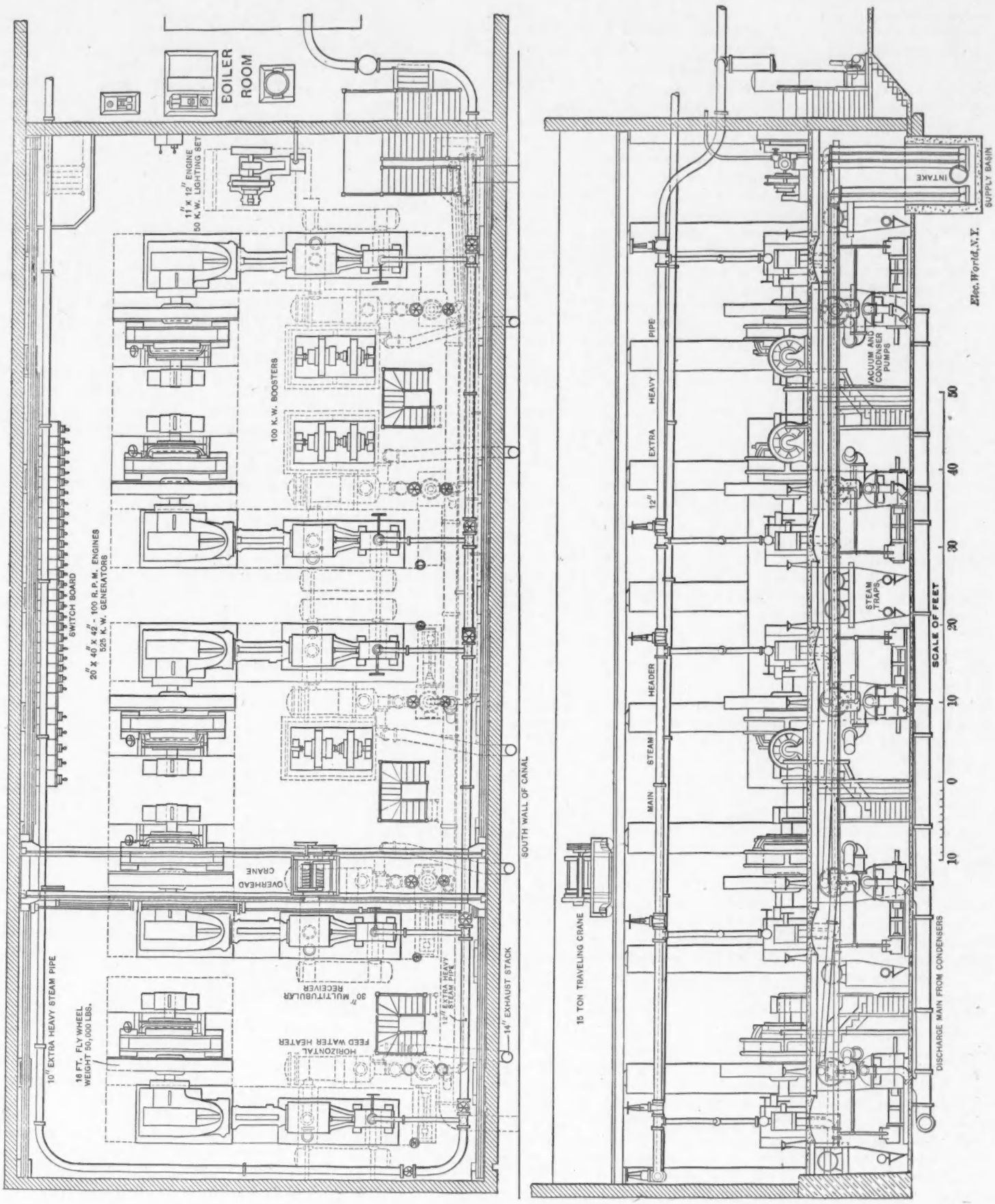


PLAN OF BOILER ROOM



SECTION OF BOILER ROOM

Floor Plans and Sectional Elevations of the Power House of the Capital


BOILER ROOM
11" X 12" ENGINE 50 K.W. LIGHTING SET
100 K.W. BOOSTERS
20" X 42" X 42" - 100 R.P.M. ENGINES 525 K.W. GENERATORS
SWITCH BOARD
OVERHEAD CRANE
30" MULTITUBULAR RECEIVER
HORIZONTAL FEED WATER HEATER
12" EXTRA HEAVY STEAM PIPE
10" EXTRA HEAVY STEAM PIPE
16 FT. FLY WHEEL WEIGHT 50,000 LBS.
14" EXHAUST STACK
SOUTH WALL OF CANAL
INTAKE
SUPPLY BASIN
Elec. World, N.Y.
VACUUM AND CONDENSER PUMPS
STEAM TRAPS
12" EXTRA HEAVY STEAM PIPE
MAIN STEAM HEADER
15 TON TRAVELING CRANE
DISCHARGE MAIN FROM CONDENSERS
SCALE OF FEET
10 0 10 20 30 40 50

Traction Company, Washington, D. C. **For Description see Pages 707 to 715.**

Electric Traction at Lyons, France.

The Lyons Omnibus and Tramway Company, which installed electric traction as an experiment on its inter-urban lines, has become convinced of the advantages of the new form of traction, and has recently changed over its entire system.

The company operates about 35 miles, almost all double track. The old rails of the Marsillon type, 51.6 pounds per yard, were not replaced at the time of the change-over. The Falk cast-welded joint was put in, as it was feared that undue wear would result at the joints from increased weight of the rolling stock. The trolley wire is No. 0, with span suspension, made fast to the walls of the houses or to ornamental metal poles. The method of suspension used on the steel bridges over the Rhone is arranged to bring the poles of the railway to correspond with the pillars supporting the bridge. On the southern bridge no poles are used and, instead, rosettes have been fixed to columns which surmount each pillar of the bridge.

When permission was granted by the city government to substitute electric traction for horses throughout the system overhead wires were forbidden in streets with a total distance of about 2 miles, and here an underground conduit system was put in. Both positive and negative conductors of this portion of the system are insulated from the rails and are connected with the station by special feeders.

The feeder system is underground, and consists of rubber-covered, iron-armored cables, and, owing to the distance of the station from the centre of distribution, the copper cross section is rather large. There are twenty-four positive feeders leaving the station, with a total length of 58,000 feet; all feed points are provided with switches to enable that particular cable to be cut clear of the line in case of a short-circuit somewhere along its length.

The cables which cross the Lafayette Bridge are lead-covered to prevent any action on the rubber due to their exposure to the air. These cables enter a cast-iron junction box at each end of the bridge where they may be got at for the purpose of testing their insulation.

The calculation of the positive feeders was based on Kelvin's formula for greatest economy. The return copper, however, could not be calculated in this way, it being necessary to avoid electrolytic action on water and gas mains, and to comply with the governmental regulation on base conductors in the earth, which require the different points where the latter are bonded to the rails to be all at the same potential. This requires the same drop over each return cable back to the station, and hence the longer cables had to be given a very large cross section.

In addition, pilot wires brought back to instruments at the station permit the existing difference of potential between the various extremities of the cables to be known, which enables them to be adjusted by variable resistances which are kept in circuit.

The rolling stock of the company comprises 175 motor cars and 60 trailers, which are used on the suburban lines on days of heavy traffic. The motor cars are of two kinds, one with seats on the roof, carrying sixty passengers in all, the other without, and having a capacity of forty-five passengers. They have first and second class compartments.

Each motor car is equipped with two G. E. 800-hp motors and B-A controllers, with electric brakes. There is also an automatic circuit breaker instead of a fuse. In compliance with a municipal regulation each car carries two "Volta" speed indicators especially built for this work. A few of the cars are provided both with the overhead trolley pole and a collector or plow to be used when they are running over the underground conduit, and which is pulled up under the car when not in use.

The station, one of the largest yet built in France, is outside the city limits, a little over 2 miles from the centre of the town. It is equipped with four groups of 450-kw generators. The engines were built by Piquet, of Lyons, and are rated at 750 horse-power, and can be pushed up to 1100 horse-power. They are of Piquet's usual design, simple condensing, with slide valve and variable cut-off. The cylinder diameter is 33 inches and the stroke 43 inches; the speed is 90 r. p. m. The flywheel is 20 feet in diameter and weighs 45 tons.

Steam is generated in a battery of 12 semi-tubular boilers, having 721 square feet of heating surface each. The piping was very carefully laid out, and is a duplicate system, arranged with valves, so that any boiler or set of boilers can be used to furnish steam to any engine. The feed water may be introduced into the boilers by the engine pumps, by two Worthington pumps, or by four Koerting injectors.

The piping is all iron with copper expansion pieces. Both boiler feed water and condenser water can be taken from two large wells. 15 feet in diameter, 40 feet deep, sunk in a very abundantly watered stratum of earth. One well is sufficient to supply all the condenser water needed for the two engines when running at full load; nevertheless, to minimize the chances of an enforced idleness, resulting from a prolonged drought, a "Lee" cooling system was put in, permitting the water which has been used in the condenser to be cooled by being sprayed into the air with centrifugal pumps.

The feed water can be passed through a Green economizer before entering the boiler. There are two of these for each set of six boilers. There are two chimneys, 160 feet high, and with an inside diameter of 8 feet at the top.

The generators were built in Paris. The armature is keyed to the engine shaft. The field has 8 poles, with compound winding, over-compounded so as to give 500 volts at no load and 575 volts at full load. The normal output of each machine is 750 amperes, but they will carry 1100 amperes for several hours without injurious heating.

Before long it is expected to put in a 1 to 1 motor generator, taking current at 550 volts, and delivering at 550 volts, which will be used to feed the underground trolley system, so as to render the latter entirely independent of the rest of the road.

The switchboard is arranged so that all the generators may be run in parallel on all the feeders, or any combination of feeders may be put in any single generator. The four machine panels are provided each with a "Volta" ammeter, two main switches, an automatic circuit breaker, and a shunt field rheostat. The six feeder panels are each provided with an ammeter, two switches and a circuit breaker. They are also provided with lightning arresters, of the magnetic blow-out and impedance-coil type. The centre panel is especially arranged for the underground trolley portion of the road and for measuring instruments. On this panel there is a hand wheel controlling a movable electrode of a water rheostat in the basement.

This rheostat is intended to be used to cut down the voltage on the underground trolley when the latter becomes flooded, and also in case of a short circuit on the line it is to be used to keep the current within the capacity of the machine, while at the same time burning off the ground. The voltmeters connected to the pilot wires mentioned above, are located on this panel. After shutting down the road at night it is possible with the aid of the rheostat to send a heavy current between two points on the rail where two negative cables are bonded on, and determine from the observed drop what the condition of the Falk joints is electrically. These measurements are made regularly, and any necessary repairs carried out at once, which is a large factor in keeping down electrolytic troubles. Two Weston voltmeters complete the switchboard outfit.

In addition, there is a very complete laboratory containing delicate instruments (Thomson and d'Arsonval galvanometers) with which the insulation resistance of both positive and negative feeders may be tested, and also freedom from ground of the generators and the car motors. Every test necessary for the maintenance of such a fine installation is arranged for.

The engine room has a traveling crane of 70 tons capacity and 46 feet span. The mechanical part was furnished by Piquet and Bonnet Spazin, of Lyons, the electrical part by Postel-binay. It is operated by electricity at 110 volts from a special plant, which serves also for the lighting of the station. The controllers for the crane have magnetic blow-outs and resemble the car controllers.

The first electric line started to operate in April, and now the whole road, except the underground trolley portion, is being electrically operated. Since the change over the traffic has increased so much that the facilities provided by the company have proved inadequate, and the number of cars in service is to be considerably increased.

Already the station equipment is receiving an addition of two more generating sets like the first, six more boilers, a chimney and an economizer, and this is probably by no means the last extension that will be made.

When finished, this plant will have six sets of 450 kilowatts capacity each, and will be one of the largest put in by the companies who exploit the Thomson-Houston system in Europe.

The Keely Motor.

The stockholders of the Keely Motor Company propose to place the machine and all available data in the hands of F. B. Kinraide, of Spring Park Laboratory, Boston, for a general investigation.

The Most Efficient Thickness of Transformer Plate.*

BY F. BEDELL, R. M. KLEIN AND T. P. THOMPSON.

In a magnetic circuit built up of plates or laminæ of iron, cyclic reversal of magnetism is accompanied by a loss of energy due to hysteresis and eddy currents, the hysteresis loss being proportional to approximately the 1.6 power of the magnetic induction B, and the eddy current loss being proportional to the square of the induction and the square of the thickness of the laminæ. These losses may be expressed by the following formulæ, due to Steinmetz. The hysteresis loss in watts is

$$V \eta n B^{1.6} 10^{-7}.$$

Here V is the volume of cubic centimetres, n the frequency, B the induction per square centimetre, and η a hysteresis coefficient dependent upon the quality of the iron. In the present investigation the value .002 has been assigned to this hysteresis coefficient.

The eddy current loss in watts is

$$V\gamma (tnB)^2 10^{-21},$$

where t is the thickness of the plate in mils, including oxide or insulation. It is 1000 times the reciprocal of the number of plates per inch. The coefficient γ, the conductivity of the iron, is here taken as 10^6.

For very thick plates (so thick that we approximate the condition of a solid core) these formulæ do not hold, but they are substantially correct for the thickness of plate considered in this investigation. According to these formulæ the hysteresis loss is independent of the thickness of plate; the eddy current loss varying, however, as the square of the thickness of plate increases very rapidly as the thickness is increased beyond certain limits. The direct effect, therefore, of decreasing the thickness of plate is to decrease the losses. There is an indirect effect, however, tending to increase the losses as the thickness of plate decreases. For a given value of total magnetic flux in the magnetic circuit the magnetic density increases as the thickness of plate decreases, since the per cent. of space occupied by air space, oxide and other insulation increases. Consequently as the thickness of plate decreases the hysteresis loss increases; the eddy current loss decreases as long as the thickness t is the controlling factor, and suddenly increases when the magnetic density B increases to such a value as to more than counterbalance the effect of the decreased value of t.

It is evident that for some particular value of t there will be a minimum total loss for a given frequency and for a given total flux. It is our purpose to determine if possible the value of t which will make the total loss a minimum.

The curves in Fig. 1 are computed from the formulæ given above, on the assumption that the thickness of air space, oxide and other insulation (designated by a) is 1.83 mils. This was an average value found from a series of measurements on transformer plates. If B represents the magnetic density which we would have in case the plates were solid (B equals the total flux divided by the gross area of core), we will have for any thickness of plate t

$$B_t = B\frac{t-a}{t}.$$

In Fig. 1 we have curves for the following cases which represent considerable range of practice :

Curve I. $B = 3470$; frequency $= 125$.
Curve II. $B = 2170$; frequency $= 125$.
Curve III. $B = 7240$; frequency $= 60$.
Curve IV. $B = 4530$; frequency $= 60$.

Each of these four curves shows the total loss (in watts per pound) including hysteresis and eddy currents for the particular frequency and induction assumed. These were constructed by first plotting curves of hysteresis and eddy current losses separately; thus, curve III. is the sum of the hysteresis loss curve H, and the eddy current loss curve E. An inspection of curve H shows that the hysteresis loss increases as the thickness of plate decreases, slowly at first and then rapidly. With a decrease in the thickness of plate the eddy current loss is at first rapidly diminished and then suddenly increases for very thin plates.

It is interesting to note that the four curves for total loss have minimum points for about the same thickness of plate, this minimum point being very flat, in fact practically covering the range from 10 to 15 mils.

In order to make the conclusions of value it was deemed necessary to consider the influence of a different value of a, thickness of the insulation and air space, upon the results. Evidently for different values of a the value of t for minimum loss will be changed. The solid curve in Fig. 2 shows the thickness of plate for minimum loss in terms of thickness of insulation a, when B equals 4,170 and frequency equals 60. Data for this curve were obtained by plotting a series of curves, similar to those shown in Fig. 1, each for a different value of a; the minimum points were picked from these curves to construct the curve in Fig. 2. The exact minimum points were difficult to locate on account of the flatness of the curves. But the exact minimum we do not want; it is more important to know the range in the values of t, which gives what is practically a minimum loss. The dotted curves have been drawn in Fig. 2 showing the limits of variation, provided the loss does not exceed the minimum loss by more than (approximately) one per cent. The thickness of insulation a may vary about 50 per cent. without taking us beyond those limiting dotted curves for a particular thickness of plate. The best thickness of plate increases as the insulation space is increased.

We thus see that there is a wide working range for the best thickness of plate, say from 10 to 15 mils, which will be sufficiently near the minimum point for practical purposes, for any ordinary range of induction or frequency, or thickness of insulation.

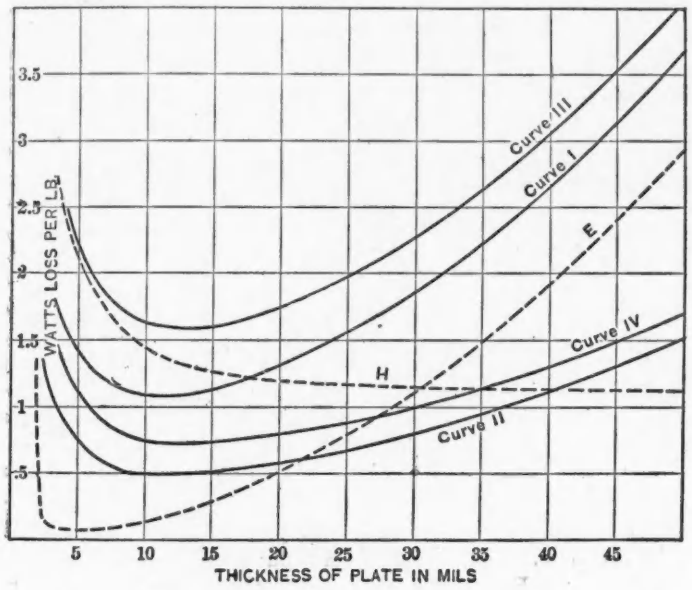


Fig. 1.

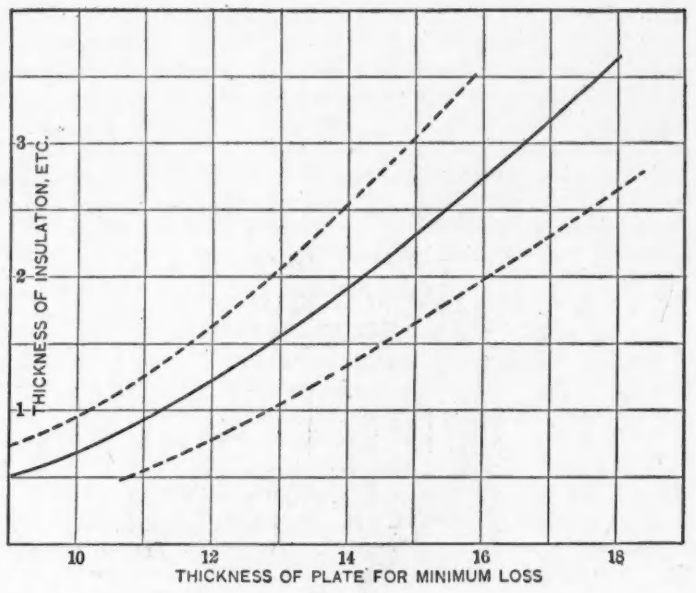


Fig. 2.

*Read at the Boston meeting of the American Association for the Advancement of Science, August, 1898.

The Convention of the Northwestern Electrical Association.

The seventh annual convention of the Northwestern Electrical Association will be held at the Hotel Pfister, Milwaukee, Wis., commencing on Wednesday morning, January 18, 1899.

The following papers will be read and discussed: "Trend of Central Station Design," by B. J. Arnold, Chicago; "Meter-Rate Systems," by E. L. Debell, Sheboygan, Wis.; "Design of Secondary Circuits in Alternating Plants," by George L. Thayer, Belle Plaine, Ia.; "Electricity Direct from Coal," by Prof. A. J. Rogers, Milwaukee; "Inductive Loads on Alternating-Current Transformers," by Prof. D. C. Jackson, Wisconsin University; "Electric Vehicles and Their Relation to Central Stations," by H. M. Maxim, Hartford, Conn.; "Association Management," by H. L. Doherty, Madison, Wis.

The association will, at this meeting, handle the "question box" in a new way, the members and attendants being requested to mail to the secretary, Thomas R. Mercein, 22 Sentinel Building, Milwaukee, before January 10, any question they may desire answered. All questions received will be printed in the final notice of the convention, with a request that prepared answers be ready at the meeting. The usual one-and-one-third fare for railroad transportation has been arranged for, as well as reduced rates at the hotels and the customary amusements.

Improvements in the Ferranti Dynamo.

The alternating-current dynamo of the type provided with a disc armature constructed of a series of flat coils, and without iron in the armature, exxamples of which are the Ferranti and Mordey machines, has never come into any extended service in this country, although quite widely used in England. Improvements in this type of machine have been covered by patent No. 615,265, issued December 6, to S. Z. de Ferranti, of which the following description gives a general idea.

The aim of the improvements is to insulate the frame holding each pair of armature coils from the body of the machine so that the insulation separating the conducting wires of the coils from the frames need not be sufficient to withstand the total voltage of the machine, but only that generated by the pair of coils, the main

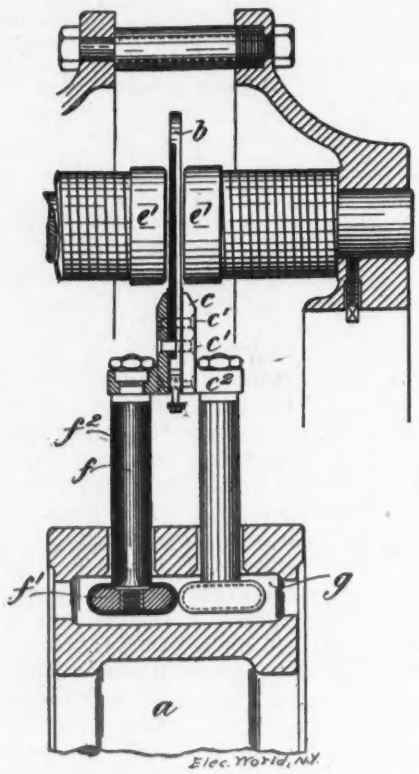


Fig. 1.

strain coming across the insulation between these frames, holding each a pair of coils and the fly-wheel rim, if the coils are mounted on its periphery, as in the Ferranti machine, or the stationary armature frame, if the coils forming the disc armature project inwardly between the poles of a rotating field, as in the Mordey machine. The form of construction is shown in Fig. 1, in half-section. The poles e' e' send lines of force across the air-gap, in which runs the flat armature coil b gripped tightly in the frame c by means of bolts c'. The frame carries lugs c^2, engaging with the rods f, which are attached to the rotating wheel a by means of nuts f' bedded in the insulation and cemented into the annular cavity g by means of sul-

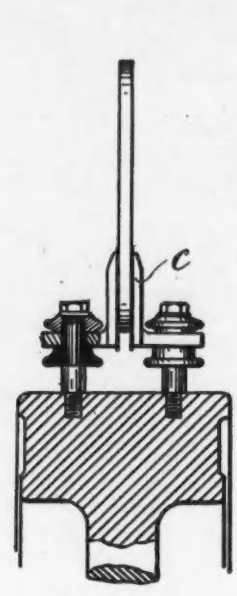


Fig. 2.

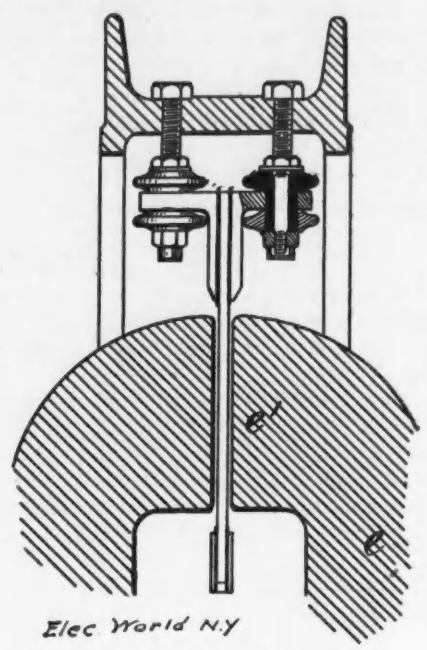


Fig. 3.

phur or some similar insulating material. The rods f may also be surrounded by insulating tubes of vulcanite, mica or other material, as shown at f^2, to prevent surface leakage. In this way, provided the poles are capped with some insulating material, a very high voltage can be generated in such a machine with a comparatively thin insulation on the armature windings themselves.

Fig. 2 shows a little different arrangement, the lugs of the frames c being insulated from the rods projecting from the wheel-rim by devices closely resembling single-petticoat line insulators. Fig. 3 shows a similar arrangement for a machine, with a stationary inwardly projecting disc armature and rotating field. Fig. 4 shows a modification of this arrangement designed for still higher insulation, the frame of the coils being attached to a lug j cemented into a cavity g in the cast frame a. This design obviously gets around the

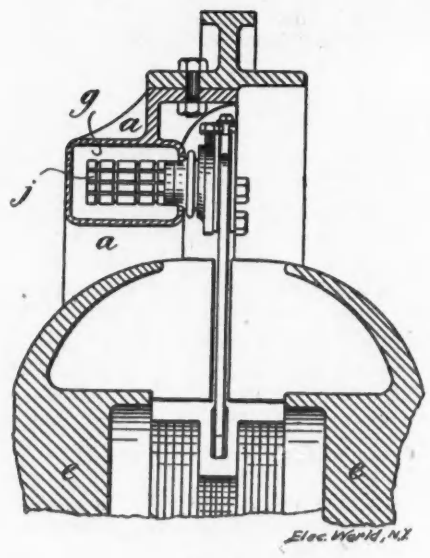


Fig. 4.

difficulty found in slotted-armature machines generating high voltages direct, in that, if the winding is at all well distributed, the greater portion of the volume of the slots must be taken up by insulation, leaving a very small space for copper.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering.

Dynamos, Motors and Transformers.

ROTARY CONVERTERS.—Lond. "Elec.," Dec. 9.—A brief editorial discussion. The views of the various speakers in the discussion of Thompson's recent paper (see "Digest" last week) are summarized; it seems to be generally admitted that the single-phase rotary converter is not an advantageous machine to use except in small sizes, the experience of Mengarini, at Rome, being taken as a typical instance; there they are being replaced by motor generators on account of the difficulties with sparking and hunting when running in parallel. It is generally considered that if the continuous current must be regulated over more than a few volts, the boosters or similar devices absorb any advantage over the motor generator; except when the frequency is low, 40 or lower, the large number of poles and brushes is a disadvantage; but where three, four, or more phases are used with low-frequency currents, and where no extended regulation is necessary, such converters have given and will continue to give satisfaction. It is offered as a suggestion that whereas in a continuous-current generator the only change in current is that occurring under the brush when the coil is not in circuit, in the case of the rotary converter it occurs during every part of the revolution; this effect of self-induction should receive attention. In the abstract of the discussion as published in the Lond. "Elec." a table offered by Esson is reproduced; it shows the ratio between the alternating and direct currents, as obtained in the experiments which he made.

ROTARY CONVERTER. Miot. "L'Elec.," Dec. 3.—A brief, illustrated description, with some data, of one of those installed in Paris. The voltage is 3,000, which is lowered to 160 by means of transformers; the output of the machine is 88 kw.

THREE-PHASE MOTORS WITH SINGLE-PHASE ARMATURE WINDING. Cahen. "Elek. Zeit.," Dec. 8.—An article giving the theory and offering an explanation of the curious phenomenon noticed by Goerges (see "Digest," Sept. 12 and 19, 1896); this phenomenon was that if a three-phase motor contains an armature having a single-phase winding it will run not only at the normal but also at about half this speed. He begins by describing the observations made by him. The mutual actions of the two windings will be analogous to that in a single-phase motor, except that the action will be manifested in the opposite direction; the reaction of the armature consists not only in the generation of a rotating field opposite to that of the primary circuit, but also in the simultaneous production of pulsations in the primary winding. In conclusion he remarks that there does not seem to be any prospect of making use of such motors in practice; their action is dependent to a great extent on the relations of the total resistance of the primary circuit, and the same motor will therefore act differently according to the condition of the circuit or the primary station to which it is connected; the general theory of such motors, however, is of interest, as it shows among other things what advantages are offered by the application of two rotating fields in alternating-current problems.

THEORY OF GOERGES PHENOMENON. Eichberg. "Zeit. fuer Elek.," Dec. 4.—The first half of an article in which he offers an explanation of this phenomenon (see also abstract above); it is based on two revolving fields in the armature.

REVOLVING FIELD MOTORS. Hanappe. "L'Eclairage Elec.," Nov. 26 and Dec. 3.—The continuation of his long serial. He discusses formulas applicable to non-synchronous motors with revolving multipolar fields. It is of a mathematical nature.

MULTIPHASE ELECTRIC MACHINERY. Stewart. Lond. "El'ty," Nov. 26, Dec. 2 and 9.—An article of a somewhat elementary nature giving the leading features of the system, with special reference to the efficiency and regulation of the generators and motors.

THREE-PHASE PATENTS IN GERMANY.—Lond. "Elec.," Dec. 9.—A note stating that according to a German paper the decision of the German courts as to the invalidity of the Tesla three-phase patents owned in that country by the Helios Company, has been confirmed.

SINGLE-PHASE INDUCTION MOTOR. Baxter. "Power," Dec.—A brief description of the principle of such motors.

Lights and Lighting.

LIFE OF SMALL AND LARGE LAMPS.—Lond. "Elec. Eng.," Dec. 9.—Several answers to a request to compare the efficiencies and life of incandescent lamps of large and small candle-power respectively. A short table is quoted from Preece's Brit. Assn. paper of 1896, giving details of a large number of experiments; this shows that there is a saving of about 15 per cent. in the meter bill when 8-cp lamps are replaced by the equivalent number of 32-cp lamps; if they are replaced by 100-cp lamps there is a saving of nearly 33 per cent.; this saving, however, cannot all be realized, as the distribution of light is not so good. The surface of a bulb for a 16-cp lamp ought to be twice as great as that of an 8-cp lamp, otherwise it will deteriorate more rapidly. If the watts per cp of the various lamps is the same, then the higher the candle-power of the lamp the longer is its life; the larger lamp will also maintain its candle power more steadily than the smaller, but the illumination is not so pleasing. Another answer gives a curve showing the percentage variation in candle power for a given per cent. of variation in the volts over a range of 10 per cent. A table is also given showing the average life at a constant e. m. f., and also at one which varies; at a 4 per cent. variation in pressure almost half the life of the lamp is sacrificed, while a 7 per cent. increase reduces it by two-thirds nearly.

Power.

VERY LONG DISTANCE TRANSMISSION. Forbes. Lond. "Elec. Eng.," Dec. 9 (in abstract in Lond. "Elec.," Dec. 9.—The conclusion of the reprint of his paper (see "Digest" last week). In this portion he describes some quick methods which appear to be quite useful for making preliminary estimates quickly. In all such work on the cost of a long conductor he never takes notice of its resistance, nor of the value of the current, but deals only with the current density and the loss of volts; he never uses the efficiency of the conductor system, but prefers the "inefficiency" or the reciprocal of the efficiency—that is, the horse-power put into the beginning of the line to deliver 1 horse-power at the other end. If the power costs absolutely nothing, the copper would be least and the arrangement the cheapest when the inefficiency is 2 that is the efficiency 50 per cent.; with a greater or less current density more copper would be required to deliver the same quantity of power. This is shown in Fig. 1, which shows that the copper required to

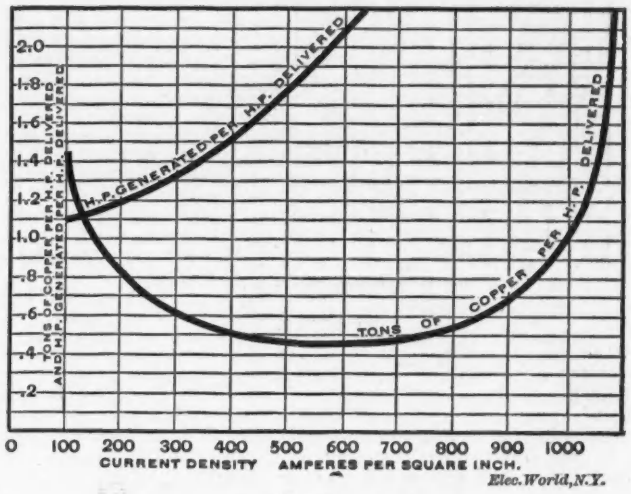


FIG. 1.

transmit 1 horse-power 100 miles at 10,000 volts, with continuous current, falls with the increase of density until the efficiency is 50 per cent., and then rises again; this diagram shows the weight of copper required per horse-power delivered at a distance of 100 miles at 10,000 volts, or 150 miles at 15,000, 200 at 20,000, etc.; it is for continuous currents, and should be corrected only for temperature and sag; it is equally applicable toa single-phase or two-phase alternating current transmission to 100 miles at 10,000 effective volts, or at 5000 effective volts from any wire to the middle of the electric system, or to three-phase transmission to 100 miles at 5000 effective volts from any wire to the middle of the system; but with alternating currents corrections must be made for self-induction and capacity. Another curve may be drawn showing the inefficiency, and this curve constantly rises. From these two a third curve can be deduced which gives in a few minutes all the main features that one wants for any horse-power delivered to any distance at any voltage; this gives the tons of copper per horse-power delivered at 100 miles at 10,000 volts in terms of the horse-power generators per horse-power delivered. This is shown in Fig. 2; the horizontal distances give the inefficiency and the vertical distances the corresponding tons of copper per each horse-power delivered at 100 miles; it also shows the current density in amperes per square inch section of copper. This is the curve which he uses constantly; it is correct for any case in which the volts equal 100 times the miles; the current density and weight of copper per horse-power is the same whether 10,000 volts at 100 miles are used or 100 volts at 1 mile; for any other volts and distance, V and M, divide the volts by the miles and then one-hundredth of this equals D, the multiplier for the current density; the square of this D equals T, the divisor for the tons of copper per horse-power. There is another use for this curve; if the cost of

running the station is capitalized and the cost of the generating works added and divided by the horse-power, it gives the capitalized value of 1 horse-power generated; divide the value of the horse-power by that of the tons of copper and draw a line across the axis, so that it cuts the axis in that ratio, and then draw a line parallel to this, touching the curve; this gives, according to Ayrton and Peary's modification of Kelvin's law, the point of maximum economy, giving directly the inefficiency, the tons of copper per horse-power and the current density. Two examples are shown on the curve, one in which the value of 1 horse-power is four times that of a ton of copper, in which case the greatest economy will be with an inefficiency of 1.18, a current density of 180 and 0.91 ton of copper per horse-power delivered at 100 miles at 10,000 initial volts. Another example is shown on the curve when "the horse-power is one-fifth of the cost of a ton of copper:" the efficiency then is 1.58, current density 420, and copper 0.51 ton. To do this for other values of T (see above) divide the capitalized value of the horse-power generated by T; lay this off vertically and measure the cost of a ton of copper horizontally; join the two points by a line and draw a parallel line touching the curve at the point of maximum economy. This curve, therefore, becomes very valuable for obtaining the very information which an engineer requires in his first examination of any project. Furthermore, by dividing the tons of copper per horse-power by eighteen times the distance in miles, it will give the sectional area in square inches of the conductors per horse-power, and this multiplied by the total horse-power to be delivered gives the size of the conductors. Corrections for temperature, sag and alternating currents must be made. For those who prefer tables instead of curves he reduces these curves to tabular figures, which are given and are accompanied by rules for using them. In conclusion he states that whenever gold mines exist which can afford to pay $1.25 to $1.50 per ton of ore milled, and if there is a good water

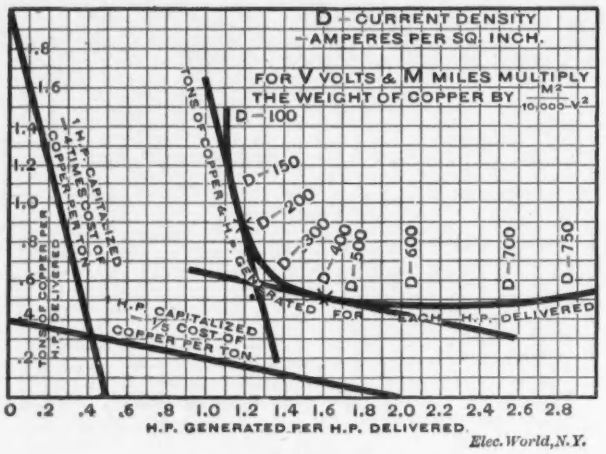

D = CURRENT DENSITY
= AMPERES PER SQ. INCH.
FOR V VOLTS & M MILES MULTIPLY
THE WEIGHT OF COPPER BY M²/10,000 V²
D = 100
D = 150
D = 200
D = 300
D = 400
D = 500
D = 600
D = 700
D = 750
TONS OF COPPER & H.P. GENERATED FOR EACH H.P. DELIVERED
1 H.P. CAPITALIZED = 4 TIMES COST OF COPPER PER TON
H.P. CAPITALIZED = ¼ COST OF COPPER PER TON
TONS OF COPPER PER H.P. DELIVERED
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0 .2 .4 .6 .8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8
H.P. GENERATED PER H.P. DELIVERED
Elec. World, N.Y.

Fig. 2.

power within 400 miles, it is quite probable that it would pay well to transmit the power electrically. This is followed by the discussion, which, however, appears to contain nothing of importance.

In an editorial discussion in the Lond. "Elec. Rev.," Dec. 9, it is questioned whether the copper merchants would be satisfied with a 4 per cent. mortgage on the copper in the line, as suggested by Forbes, as in case of failure the value of the copper as an asset is not equal to the mortgage; 4 per cent. is therefore not a sufficient return; the cost of removal of the copper in case of failure must be considered; moreover, its value will only be that of the raw material at the price which the wire-drawer would have to pay for it, and the mortgage would be limited to that value.

A reprint of his paper is begun in the "Elec. Rev." (N. Y.), Dec. 21.

POLYPHASE TRANSMISSION OF POWER. Wallis. Lond. "Elec.," Dec. 9.—An article comparing the various systems of transmission with one another, with special reference to the polyphase system. Much that he says has already been published, but it appears to be a good summary. Although the direct current has been used over considerable distances and up to 15,000 volts at Brescia, there are many disadvantages connected with it; its chief promoter, Thury, admits that the maximum output of such dynamos is about 45 amperes at 3000, or at most 4000 volts, and hence for 15,000 four or five machines must be coupled in series as generators and similarly as motors; that is, large economical generators at low first cost cannot be used; there is, however, a saving of copper as compared with any of the alternating systems, the relative figures for direct-current, single-phase, two-phase, four-wire and three-phase circuits being 0.50, 1.00, 1.00 and 0.75, assuming the same maximum potential in each case; the gain in copper is even greater, as the power factor of alternating-current systems is less than unity, thus involving a greater current, corresponding to the power transmitted. On the other hand, the disruptive discharge due to the alternating e. m. f. is sluggish; it would, for instance, take an alternating e. m. f. of more than 15,000 divided by the square root of 2 effective volts to produce the same disruptive effect as a continuous e. m. f. of 15,000 volts; there is no electrolytic effect of the alternating current, nor does the osmotic effect, whereby moisture creeps to the negatve pole of a continuous-current circuit, exist; although there would be considerable saving in copper in the line for the continuous current, that system is impracticable. The single-phase, alternating-current system is well adapted for long distances, with one receiving station with one or two large motors; according to text books, it requires more copper in the line than the three-phase, in the proportion of 100 to 75, but this is not quite true in practice, as with such motors there is practically no lagging current, whereas with three-phase transmission the power factor rarely exceeds 80 per cent.; the real objections are that the motors must be synchronous, and that rotary converters for transforming them into continuous currents cannot be made of a larger capacity than 50 kw, on account of excessive sparking; the synchronous motors cannot be started without external aid, and they require separate field excitation, although this is not so important for transmitting to a single large motor, while for numerous small motors these complications make it prohibitive; no self-starting induction motors have yet proved themselves sufficiently satisfactory for general adoption for the single-phase system. The self-starting difficulty is entirely overcome by the polyphase system, in which even synchronous motors will start themselves, and they have a power factor of nearly unity when properly excited, and thus there will be a saving of 25 per cent. in the line copper over the single-phase system; in spite of their lower power factor, induction motors are far more generally employed on such circuits, and with these there is no difficulty in starting, even with full load; up to 10 horse-power the motors are generally made with a squirrel-cage rotor, and these take two or three times the normal current when starting under full load; larger machines are provided with a variable resistance in the motor circuit, and will start under full load, taking only the motor current. The polyphase system is well adapted for rotary converters; the tendency to sparking and the demagnetizing effect of the armature is even less than with continuous-current dynamos, since the armature reactions tend to neutralize one another. The limit for a 20-hp motor is about 1000 volts; for smaller ones static transformers must be used. Lamps may be run from the low-pressure polyphase circuits, being preferably connected to a fourth balancing wire, thus involving the star connection; the voltage regulation is then more satisfactory, and the voltage between the mains is raised to the square root of three times that required by the lamps, thus requiring less copper in the mains; motors on such circuits act as automatic regulators for the voltage, due to a slight unbalancing. Many engineers, nevertheless, prefer the two-phase system with four wires. He speaks favorably of the transformation of three-phase to continuous currents by rotaries, which act not only like transformers but also as boosters, for the field winding may be compounded, thus making the full load voltage greater than that at no load. Such a combined system is particularly well adapted for traction purposes; where the distribution is mixed—that is, for both motors and lights on the same circuits; the question is not so easy of solution; wherever regulation will be difficult it will be more economical to use a simpler system, even at an increased first cost. The regulation of speed of the motor is effected by a variation of the resistance of the rotor circuit, or where a large starting torque is not required choking coils may be used; the speed may be altered by changing the number of poles, by changing the connections from star to mesh, and by coupling two motors together, so that the rotor circuit of the one supplies the stator of the second; generally regulation is effected by resistance in the rotary circuit, although it reduces the efficiency considerably. For equal power the weight of the polyphase motor is less than that of the direct-current machine, and it can stand considerable overloading; there is very little difference in efficiency, power factor, starting torque and exciting current between the two-phase and the three-phase motors, the slight difference being in favor of the three-phase. When the load consists chiefly of induction motors the power factor varies between 0.65 and 0.85, being, as a rule, between 0.75 and 0.8; the motors and transformers and not the line are the chief sources of lag; a few large synchronous motors will compensate it to a considerable extent, as when over-excited they will act as condensers, generating a leading current. In power factor the advantage of the three-phase over the two-phase motor is practically negligible; as the load decreases the power factor also decreases. With polyphase motors the frequencies are considerably lower than 100 per second, as high frequencies increase the number of poles, the magnetic leakage, the magnetizing current and the skin effect in conductors; in the majority of the polyphase plants in America the frequency is 25 and a little over, while in Europe it is somewhere over 40.

COMBINED DESTRUCTOR AND LIGHTING PLANTS. Scott. Lond. "Elec. Rev.," Dec. 9.—A short article calling attention to several points in connection with such combined plants. If it is decided to use destructor steam for electric lighting purposes, instead of for sludge cremation, which latter he considers a more legitimate object, then the destructor plant should be considered only a sub-station or as a small station prior to the erection of a larger one; the location of the main lighting station should be considered on its own merits. He does not favor the argument that the same staff can be used for both stations; each should be controlled by a separate committee and by different managers. On account of the dust, the two stations should be isolated as far as possible. As destructor plants are large, the item of steam piping will be considerable; the irregular supply of refuse involves storage difficulties; under the best conditions the steam pressure will vary considerably.

DESTRUCTOR PLANT.—Lond. "Elec. Rev.," Dec. 9.—An editorial discussion of the figures concerning the Shoreditch plant.

STEAM TURBINES AND UNIPOLAR DYNAMOS.—Lond. "Elec. Rev.," Dec. 9.—A communication from the Parsons Com-

pany stating that that company has constructed unipolar dynamos driven from steam turbines; one of them is working successfully, and is believed to be the first unipolar dynamo in commercial use; its output is 6000 amperes at 1.25 volts, at a speed of 1000. Another combination is shown in their catalogue in which a unipolar dynamo of 150 kw at 5000 revolutions is driven by a steam turbine.

ELECTRIC PUMP.—"L'Eclairage Elec.," Dec. 3.—A description of the arrangement of electric pumps at the d'Anzin mines.

ENGINES.—"Power," Dec.—Brief, illustrated descriptions of several large American engines for European lighting stations.

NIAGARA POWER DEVELOPMENT IN CANADA. Dunlap. "West. Elec.," Dec. 17.—An explanation of the controversy which has led to the present dispute between the Government and the Canadian Niagara Power Company.

Traction.

MIXED ACCUMULATOR AND TROLLEY SYSTEM IN PARIS. de Marchena. "L'Eclairage Elec.," No. 26.—An abstract, with some of the data, of the article recently read before the International Society. The data given in the abstract supplements the article in that journal which was published in its issue of June 11. He made a number of measurements on this line; the weight of the car is 10,000 kg in addition to the battery, which weighs 3800 kg, and passengers weighing 4000 kg, making a total of 18 tons. With the empty car and fifteen stops on the trip of about 5 miles, the energy consumed was 550 watt hours per car km; with a loaded car weighing 17 tons, under similar circumstances, 625 watt hours; these are the figures obtained on the experimental trips; in actual service, with twenty-five to thirty stops, the consumption was 675 to 800 watt hours, or a mean of 750; it appears that this is the energy consumed by the motors, and does not include the losses in the lines or in the accumulators; the consumption at the central station is also given; about one-third of the distance is run by trolley and two-thirds by accumulators; the mean per car kilometre varied during three months from 1122 watt hours to 1462.

CANAL TRACTION.—Lond. "Elec. Rev.," Dec. 9.—The first of a series of abstracts of the article by Van der Wallen from the May issue of the Bul. of the Assn. of Elec. Eng., of Liege, the whole number being entirely devoted to the question of canal traction, both mechanical and electrical; the abstracts are intended to give a summary of the important points in the article. The present portion is devoted almost entirely to mechanical traction in general.

CANAL TRACTION. Galliot system. "Cosmos," Dec. 10.—A popular description of this system, which was recently described in the "Digest" and is in use in France. An outside view of the locomotive is given, as also of the propeller system, in which the propeller is attached to the end of the removable rudder.

ELBEUF. Montpellier. "L'Elec.," Dec. 3.—An illustrated description of this trolley line, one of the features of which is that the trolley wires are on the side of the street, over the curb.

RAILWAY TESTS. Schiemann. "L'Ind. Elec.," Dec. 10.—A long translation in abstract of the article noticed in the "Digest" Oct. 29.

FREIGHT CAR.—"Elek. Zeit.," Dec. 8.—A well-illustrated description, with working drawings, of the freight motor car used on a German trolley line on which there is considerable freight traffic.

RAILWAY ACCOUNTING. Mattersdorff. "Elek. Zeit.," Dec. 8.—An explanation of a graphical method for determining the gross expenses of electric railways. This method is claimed to afford not only a reliable method of determining the result but also for giving a clear idea of the relations of the expenses and giving the limits for other expenses, such as the portion to be paid to the municipality, concerning which there is some choice left; it furthermore enables one to determine other factors which are usually accepted arbitrarily. In his diagram the horizontal distances represent the income per car kilometre and the vertical distances the corresponding income per year.

LOCOMOTIVE.—"Eng. and Min. Jour.," Dec. 17.—A brief, illustrated description of the small, single-motor Jeffrey locomotive for use around iron works and steel mills.

CHICAGO.—"Elec. Eng.," Dec. 15.—A brief, illustrated description of the power house of the Union Elevated Railway, which has recently been completed.

Installations, Systems and Appliances.

THE BRIGHTON BREAKDOWN. Fleming. Lond. "Elec.," Dec. 9.—A short communication discussing the possible causes and making a suggestion. If the feeders of a shunt dynamo are suddenly short-circuited, the circuit having low resistance, but considerable inductance and not a negligible capacity, electrical oscillations will be set up in that circuit, and there will thus be rapid alternations of voltage superimposed on the normal voltage at the terminals of the field coils and armature; its effect will be to enormously increase the armature reaction for the moment, and this alone tends to demagnetize the fields, while the drop in the armature will reduce the normal shunt current; hence the oscillatory currents through the shunt may overpower the normal magnetizing currents, and they are exactly of the character required to demagnetize the iron; the reverse demagnetization sometimes finally left may be due to the final rupture of the short circuit, creating a momentary increase of current through the armature, due to inductance, and sending a wave of current in the reverse direction through the shunt magnets. These current changes are so rapid that no maximum or minimum cut-outs depending on the magnetization of iron have time to act. One remedy is a self-excitation, not from the bus bars, but from a separate exciter, or preferably a storage battery; compounding the fields is a partial remedy. This is followed by a discussion by Philip, who refers to that of Quin noticed last week; he refers to the transformer effect and to an experiment made by him, which he explains. In this the actions are that a sudden increase of current in the armature of the short-circuited dynamo suddenly removes the magnetism from the field coils, and therefore sets up a voltage in these coils, increasing momentarily the original exciting current; if the short-circuit current has been sufficiently large, the e. m. f. set up will increase the current through the exciter armature, and decrease its field current, or even reverse it; the reverse current in the exciter shunt reverses the polarity of the exciter, which in turn reverses the field of the dynamo. There are two methods of avoiding this trouble—to use separately excited machines protected by maximum and reverse current cut-outs, and excite the fields either by secondary batteries or a series dynamo. The transformer effect in shunt-wound dynamos in parallel shows that any short circuit in the armature coils must produce a drop in the voltage in its shunt circuit if the latter is connected to the bars, and it is often conceivable that a reversal of polarity may be caused; and a short circuit on the bars, if all the machines are not working at precisely the same portion of the magnetization curve, may cause some to act as a motor. It has been stated that a sudden increase of load on the bus bars, fed by shunt-wound dynamos in parallel, has caused the machines to cease to excite, while if the same load is applied gradually this will not occur.

The "Elec. Rev.," Dec. 9, contains a communication by H. C. L. In the case of a sudden short circuit the flux will not instantaneously respond to the fall of pressure and to the increasing demagnetizing action of the armature, and therefore a heavy momentary current may be generated, the energy being supplied from the kinetic energy of the machinery, accompanied by a loss of speed. It thus seems possible that the strengthening effect of the demagnetizing winding may overpower the weakening effect of the field winding, so that actually there may be a momentary reversing action which might produce some peculiar magnetic effect. No reversing action, even momentary, exceeding the coercive force of the magnetic circuit, can take place on short circuit, dead or otherwise, if it is assumed that the amperes and volts vary according to the characteristic curve.

LARGE ISOLATED PLANT.—Lond. "Elec. Rev.," Dec. 9.—A brief, illustrated description of a gas engine plant at the Royal Agricultural Hall in Islington. There are five gas engines of 63 horse-power each; a double ignition tube bracket is used, which is said to be one of the most marked recent improvements in gas engines.

PRIVATE PLANT.—Lond. "Elec. Eng.," Dec. 9.—An illustrated description of a private lighting plant in a large country seat known as Knowsley Hall; accumulators are used.

SWITCHES FOR CONTROLLING ACCUMULATORS.—Lond. "Engineering," Dec. 9.—In this continuation of the description of the former Schuckert works illustrated descriptions are given of some of the switches installed by that company for operating the regulating cells, as used at Barmen, Hanover, Duesseldorf and Altona.

Wires, Wiring and Conduits.

LOW-TENSION ACCIDENTS.—Lond. "Elec. Eng.," Dec. 9.—A translation in part of the article noticed in the "Digest" Nov. 19 (E. T. Z.)

Electro-Physics and Magnetism.

MECHANICAL REPRODUCTION OF MAGNETIC PHENOMENA. Weyher. "Comptes Rendus," No. 21; abstracted in Lond. "Elec.," Dec. 9.—A wooden shaft, with paper paddles along its whole length, is made to represent a bar magnet; when rotated it will suck in air at both ends and expel it from the central region, thus producing vortices in the surrounding medium; unlike poles will attract and like poles repel each other. A mill-wheel capable of turning on a fixed spindle represents a magnetic body. There is no attraction by the central region.

VIBRATIONS PER SECOND. Branson. Lond. "Elec. Eng.," Dec. 9.—A brief note on a recent paper in which, after calling attention to the dissimilarity of radiations transmitted by the atmosphere and those transmitted by the ether, he gives the following table showing the number of vibrations of various forms of waves. (The accuracy of some of these is amusing rather than assuring.) Vibrations per second:

288,224,000,000,000,000.	Roentgen rays.
1,125,899,906,842,624.	Photographic limit of solar spectrum.
562,949,953,421,312.	Green light.
281,474,976,710,656.	Infra red (photographic limit).
70,368,744,177,664.	Heat rays of solar spectrum, lowest direct measurement.
67,108,864.	Electric oscillations in Hertz resonator, 70 cm. diameter.
32,768.	Audible vibrations, extreme upper limit.
4,096.	Music, highest note.
32.	Music, lowest note.
16.	Water surface waves of minimum velocity.

STRATIFIED BRUSH DISCHARGE. Toepler. "Wied. Ann.," No. 12; abstracted in Lond. "Elec.," Dec. 9.—By inserting

in the circuit a spark gap and a large liquid resistance the capacity being small, he obtains stratification in the brush discharge in air. This is considered another bridge across the gulf that divides the phenomena of electrical discharge in the open air and vacuum respectively.

STRAINS DUE TO MAGNETIZATION. Knott. "Proc. R. S. Edinburgh," No. 2; noticed briefly in Lond. "Elec.," Dec. 9.—He investigated these strains in a series of nickel or iron tubes, boring them out by successive stages.

MAGNETIC PROPERTIES OF SHEET IRON. Rohr. "L'Eclairage Elec.," Dec. 10.—An abstract, with some of the tabular data, of the article noticed in the "Digest" Nov. 26.

CURRENTS MEASURED BY MAGNETIZATION. Pockels. "Annal. Phys. Chem.," 65, p. 458; noticed briefly in "Science Abstracts," Nov.—He endeavored to determine the maximum discharge current by the remanent magnetism induced in magnetic substances acted upon by the current. Ballistic galvanometers give only the average, while the remanent magnetism would indicate the maximum current. He used basalt as the magnetic substance, in order to avoid eddy currents, and the results are claimed to be very favorable. A magnetic field lasting only one-millionth of a second shows the same remanent magnetism as is induced by a field which has been kept a long time at the same strength. Hence the magnetization of the pieces of basalt, he claims, may be used to determine the current strength of lightning discharges.

RESISTANCE OF MOVING ELECTROLYTES. Hall. "Phys. Rev.," Nov.—Bosi, some time ago, described experiments which appeared to show that a velocity of 10 to 12 cm per second of an electrolyte in the direction of or contrary to the direction of an electric current passing through it, makes a very considerable change in the electrical resistance. In the present short article he describes experiments which show that if the effect exist at all it must be very much smaller than the figures given by Rosi.

POLARIZATION AND INTERNAL RESISTANCE OF CELLS. Guthe. "Phys. Rev.," Nov.—A short article showing that Wiedburg's theory of galvanic polarization demands a curve for the internal resistance, decreasing with increasing currents.

DISCHARGE OF A CONDENSER. Smith. "Phys. Rev.," Nov.—A short article on the influence of a short-circuited secondary upon the oscillatory discharge of a condenser; it appears that under certain conditions the presence of a secondary coil causes a diminution of the natural period of vibration of the primary circuit. The article is theoretical in character.

MAGNETIC DEFLECTION OF CATHODE RAYS. Merritt. "Phys. Rev.," Nov.—Descriptions of experiments to determine whether direct or reflected cathode rays are really deflected by the magnet in appreciably equal amount. The results show that if they differ at all the difference is extremely small.

Electro-Chemistry and Batteries.

ACCUMULATOR CONSTRUCTION. FitzGerald. Lond. "Elec. Eng.," Dec. 9.—In this continuation of his long serial he discusses the ampere-hour equivalent and the monad-gram equivalent of peroxide of lead, in connection with which many misapprehensions have arisen. In a previous paper he gave the value as 4.455 grams; Plante gave 4.48; in another article the present author gave 4.442 and also half of that value. The systems of charging accumulators are then discussed; this may be done with constant current, constant potential or constant power; it is not possible to say which of them is best, as it depends on circumstances; it is not only a question of economy of time but also of the equality of the active material energized by the charge; from experiments he believes that there is no doubt that the active material peroxidized or reduced at a high current density differs in quality from that produced by low-current density, the former appearing to be more conductive and possessing a higher specific capacity. Some passages from Treadwell's recent book are then reproduced. In the previous installment in the issue of Sept. 2 he discussed the mean specific gravity of a compounded mass of substances of various specific gravities; also the calculation of the size of a battery to go into a given space.

ACCUMULATORS FOR AUTOMOBILES. Reyval. "L'Eclairage Elec.," Dec. 3; "L'Ind. Elec.," Dec. 10.—Tabulated data of the Valls system of accumulators, of which three types are made, the very light, the light and the normal. It seems to be a modified Faure-Sellon-Volckmar type. For the very light cell the normal time of discharge is 5.5 hours, the output 16.5 amperes, which is 2 amperes per kg of total weight; the power is 30 watts, the capacity 85 ampere hours or 163 watt hours; a battery of 44 cells weighs 352 kg, and will run a carriage weighing 1300 kg for about 60 km at a mean speed of 12 km per hour with one charge.

SOLUTION OF NOBLE METALS. Marjules. "Wied. Ann.," 11; noticed briefly in Lond. "Elec.," Dec. 2.—An improvement of his device for dissolving gold and platinum. It consists of a revolving commutator which alternately sends the current through the cell and then short circuits it; the ratio of current to short circuit may be varied, or instead of short-circuiting the cell the current may be sent in the opposite direction. Under these circumstances platinum dissolves when it is the anode for the current which has the greater quantity, but the behavior of gold is very different; it is easily dissolved in hydrochloric, strong nitric and sulphuric acid under the influence of a constant current. The protection of the noble metals is evidently connected with some phenomenon of polarization, and if the latter is eliminated the "nobility" disappears.

CALCIUM CARBIDE INDUSTRY.—Lond. "Engineering," Dec. 9.—An article summarizing the progress made in this industry since the previous summary, which was published in July of this year; the original articles are referred to only briefly, but the references to the originals are given.

ASHCROFT PROCESS.—"Eng. and Min. Jour.," Dec. 17.—A note referring to the printed report of the company which has been experimenting unsuccessfully with this process; the principal cause of the difficulty was the formation of moss zinc. Editorially it is thought unlikely that any more will be heard of this process.

CHLORATE WORKS. Kershaw. "Eng. and Min. Jour.," Dec. 17.—An abstract of the description of the St. Michel Works, which was noticed in the 'Digest" Dec. 17.

ELECTRO-CHEMISTRY IN EUROPE.—"Elec. Eng.," Dec. 15.—Illustrated abstracts and reprints of the recent articles by Kershaw in the Lond. "Elec. Rev.," all of which have been duly noticed in the "Digest."

Units, Measurements and Instruments.

APPARATUS FOR MEASURING INSULATION. Heitmann. "Elek. Zeit.," Dec. 1.—A brief description of a probable instrument for this purpose made in Germany.

MEASURING APPARATUS. Armagnat. "L'Eclairage Elec.," Dec. 3.—Illustrated descriptions of various apparatus taken from patent specifications.

INDUCTION COIL INTERRUPTERS.—"L'Eclairage Elec.," Dec. 3; "L'Ind. Elec.," Dec. 10.—Illustrated descriptions of two forms recently shown at the French Physical Society.

HIGH-FREQUENCY CURRENTS.—"Sc. Am. Sup.," Dec. 24.—A reprint from "La Nature" of some of the details of the apparatus used by Dosne in the production of high-frequency currents.

MEASURING SHORT ELECTRIC WAVES. Cole. "Phys. Rev.," Nov.—A short article on these measurements and the transmission of such waves through water cells.

PREPAYMENT METER.—"Elec. Eng.," Dec. 15.—A reprint in abstract of the description of the Long-Schattner meter, noticed in the "Digest" Dec. 17.

Telegraphy, Telephony and Signals.

LIGHT TELEGRAPHY. Zickler. "Elek. Zeit.," Dec. 8.—A short account of some further experiments made with his system of wireless telegraphy with the use of ultra-violet light, as described in the "Digest" Aug. 13. He used a large searchlight with a metallic reflector. When the distance was 60 metres no rarefaction of the air was required in the receiving apparatus in order to give sure and correct signals. In another test the distance was increased to 450 metres, and good results were then obtained when the air pressure was 350 mm; this test was made in bright sunlight. In another test the distance was 1.3 km, and the air-pressure then was 200 mm. The length of the arc and the voltage may have a great effect on the production of ultra-violet rays, but further tests in that direction were not made.

TYPE-PRINTING TELEGRAPH. Higgins system. Lond. "Elec.," Dec. 9.—An illustrated description of the improved form of this instrument. It is claimed that a speed of twenty-five to thirty words per minute is possible, and that the manipulation is easy. Instruments have been working in London on a resistance of 1500 ohms; also between London and Folkestone, a distance of 60 miles; satisfactory tests were also made by the British Post Office.

PROGRESS IN TELEPHONY AND TELEGRAPHY. F. L. "Elek. Anz.," Dec. 4.—A review of the progress made during the third quarter of the present year.

MODERN TELEPHONY. Wehrenalp. "Zeit. fuer Elek.," Dec. 4.—The conclusion of his very long series. In the present portion he discusses telephone centrals and their construction.

UNDERGROUND TELEPHONE CIRCUITS. Zappe. "Elek. Zeit.," Dec. 1.—A long abstract of a recent paper read at Frankfort referring chiefly to the projected underground system for that city.

TRAIN SIGNALS. Hoefer. "Elek. Zeit.," Dec. 1.—A suggestion, illustrated with a diagram, to overcome some of the objections to the present system used on German railways.

SUBMARINE CABLE GRAPNELS. Bright. "Sc. Am. Sup.," Dec. 24.—The beginning of a reprint of the article noticed in the "Digest" Dec. 3.

Miscellaneous.

CARBONS. Jehl. Lond "Elec.," Dec. 9.—In this continuation of his long serial he describes the gas generators. In the issue of Aug. 26 the assorting, cutting, grinding and pointing of carbons is discussed and described, illustrations of machinery being given. In the issue of Sept. 2 he discusses coring.

ACTION OF ELECTRICITY ON PLANTS. Cook. "Sc. Am. Sup., Dec. 24.—A long abstract of his Brit. Assn. paper, which was noticed in the "Digest" Oct. 22.

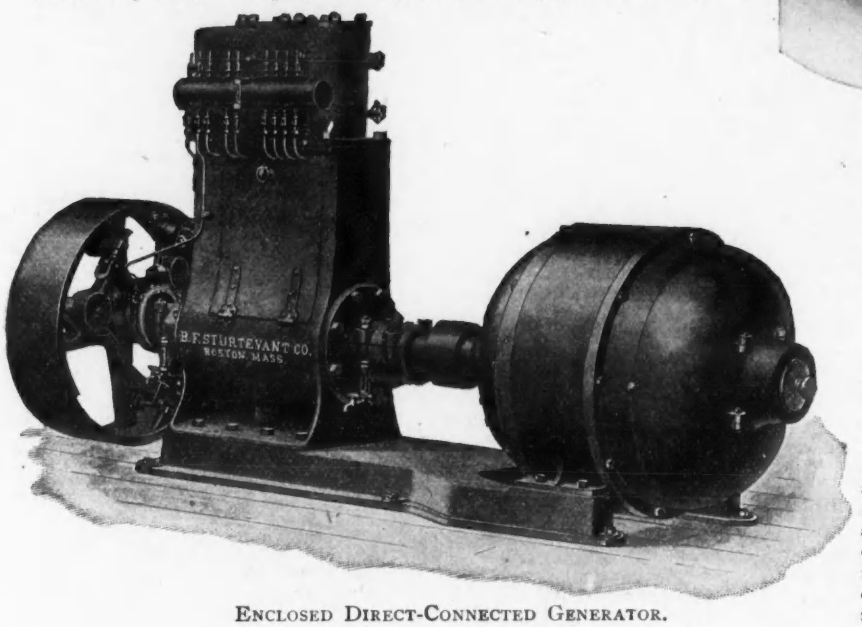
pended. The Campbell system, the invention of Mr. George L. Campbell, of Towanda, Pa., and now being exploited by the Campbell Electrical Traction Company, 451 Greenwich Street, New York, possesses some unique features. The conduit is continuous, both air and water tight, and rests upon the top of the ties. The continuous electrical conductor lies on the bottom of the conduit inside. The metallic top of the conduit is insulated from the rest of the structure, and brought into electrical contact with the conductor within by means of a specially designed trolley or traveler which runs in the conduit, the movement of the trolley being controlled by a pair of strong electromagnets in the car. The metal shoe suspended from the car floor makes contact with the top of the conduit, the current being conveyed to the motor in the usual manner. The points of superiority claimed for this system are absence of switches and other apparatus that might cause trouble. It is claimed that absolutely reliable connection between the motors and conductor can be had and maintained at all times, and there being no "make and break" of the current all the incidental dangers and annoyance arising from arcs are thus avoided. The points of the system that will strongly appeal to the practical man are the claims of low cost of installation and maintenance and ease of access for repairs, which, however, are said to be few and far between. It is stated that this system represents the possibility of perfect service under all fair conditions, and better service than is obtainable at present under the worst conditions.

The Campbell Company is considering a proposition from a local street railway company at Towanda, Pa., to test the system in actual service on 3 miles of track in that place.

Fusible Cut-Out Carbon Lightning Arrester.

Operators of exchange and toll lines and telephone users generally wish to avoid interruption of service which causes loss of revenue, inconvenience, waste of time and expense. The wisdom, therefore, of protecting the apparatus by some efficient device is self-evident.

The fusible cut-out carbon lightning arrester manufactured by the Harvard Electric Company, 52 Dearborn Street, Chicago, it is claimed, affords protection to telephones and switchboards from damage by lightning discharges and from heavy currents escaping from electric light and power circuits. It has been severely tested under all conditions and found to be reliable. The instrument is compact and very simple in construction. Owing to the absence of connections underneath no cross-talk is possible. The metal parts are mounted on a substantial porcelain base, all parts being indestructible with the exception of the fuse links.



ENCLOSED DIRECT-CONNECTED GENERATOR.

The carbon lightning arrester used alone does not afford proper protection to telephones or switchboards, neither does a fuse arrester, when used alone. The combination of the two, therefore, should be employed to secure immunity.

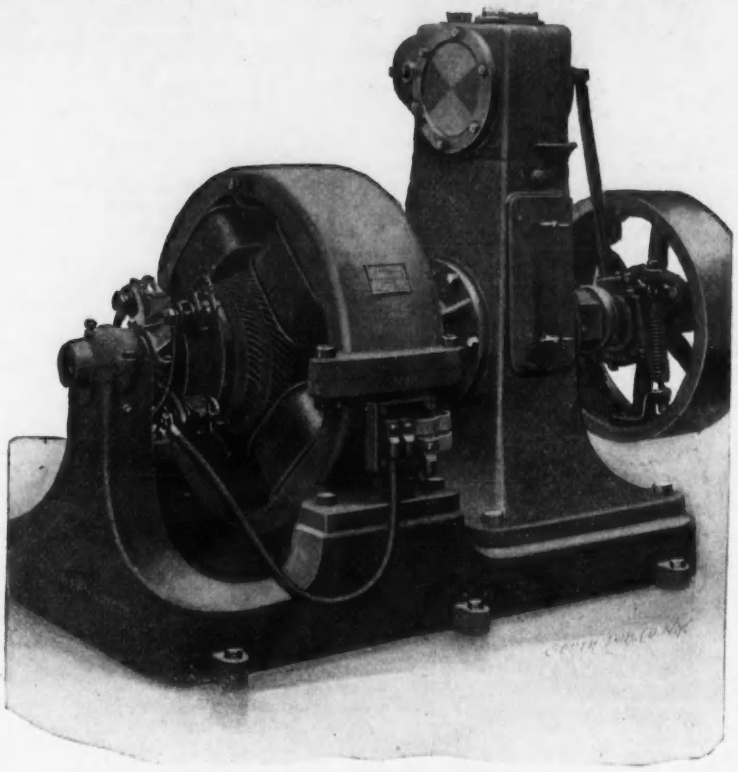
The Harvard Electric Company is prepared to furnish these arresters in any desired quantity.

A Direct-Connected Marine Set.

The accompanying illustration represents a type of marine generating plant which has found considerable favor among the officers of the Navy Department, and has been installed in some of the smaller vessels in the navy. The dynamo is a direct-connected multipolar machine manufactured by the E. G. Bernard Company, Troy, N. Y., and the outfit is similar to the one installed by the Bernard Company on the United States steamer "Mangrove," and the one more recently installed on the United States Coast Survey steamer "Blake." The officers of the "Blake," it is stated, are very much pleased with the plant, which operates so smoothly that a person standing 10 feet away from the engine, when it is running, can hear no noise from it. In some ships the vibrations from the generating plant are very noticeable. The E. G. Bernard Company has just started the work of installing a similar plant on the coast survey steamer "Pathfinder," which the Government is building to send to Alaska to survey the coast of that far-away territory.

These two plants are thoroughly up to date in design, and are complete in every respect. They include searchlight and other modern appliances, such as electric ventilating fans for the ward room, staterooms and cabins.

The Bernard Company states that it secured the contract for these plants simply through the satisfactory results obtained on the "Mangrove" and "Vixen," which are equipped with similar outfits. The engineers of the ships,

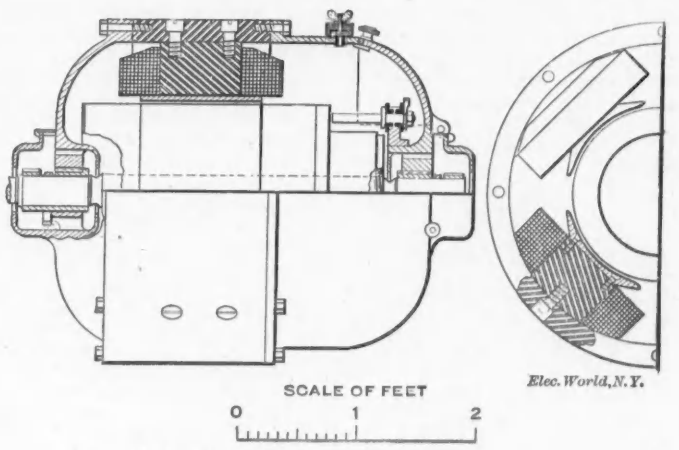


A COMPACT MARINE GENERATING PLANT.

it is stated, have praised the general design of the apparatus. The dynamo runs at 550 r. p. m. It is of the four-pole type, the armature and commutator having a large radiating surface, which keeps the temperature down to an exceedingly low degree. The engine and dynamo base, including the outboard bearing, is one casting.

The Sturtevant Enclosed Generating Sets.

A combination of engine and generator particularly suited for locations subjected to dust, grit or moisture, is that shown in the accompanying illustration, made by the B. F. Sturtevant Company, Boston, Mass. The engine is of this company's well-known double-upright type, consisting of two double-acting, single-expansion, short-stroke cylinders placed close together and connected to two cranks set 180 degrees apart, with no journal between the cranks. This gives a very even balancing of the reciprocating action, which permits high speeds without vibration. The steam is controlled by a piston valve at the fly-wheel end of the engine and driven through a rock-arm by a double-weight shaft governor in the fly-wheel. Mounted between the forks of the Y-shaped bed-plate and connected to the engine by a coupling is a four-pole generator, the enclosing shell of which is almost spherical in contour. The magnetic circuit consists of a cast-steel yoke, ring-bolted to which are cast-steel poles with cast-iron pole shoes, holding the field coils in place. The latter are tapered at the outer ends to make use of all available space for windings. The hemispherical enclosing shells are of cast-iron, provided at the commutator end with two doors hinged near the outboard bearing, giving a wide opening for inspection and attention.



SECTIONAL VIEWS OF THE GENERATOR.

NEWS OF THE WEEK

Financial Intelligence.

THE BOSTON ELECTRIC LIGHT COMPANY, Boston, Mass., has declared a quarterly dividend of $1.50 per share, payable on January 14 next.

THE AMERICAN BELL TELEPHONE COMPANY has declared a quarterly dividend of 3 per cent. and an extra dividend of 1½ per cent., payable on January 16.

THE CONSOLIDATION OF ELECTRIC LIGHT INTERESTS.—The Boston "News Bureau" states that it learns upon unquestioned authority that the New York Gas, Electric Light, Heat & Power Company has secured control of the Edison Electric Illuminating Company, of New York. The stock of the Edison company, it is stated, will be taken in on a basis of about 210 in exchange for a 4 per cent. bond. The issue of bonds has been underwritten and will be offered to the public within the next fortnight. The subscription price, it is stated, has not yet been determined, but will not be under par. This will insure something more than 8 per cent. on the Edison stock.

Special Correspondence.

NEW YORK NOTES.

"EDUCATION OF ELECTRICAL APPRENTICES AND JOURNEYMEN" was the title of a paper read before the American Institute of Electrical Engineers by Mr. Arthur A. Hamerschlag on Wednesday evening, December 28. The subject was illustrated by lantern slides.

TO FUMIGATE STREET CARS.—Col. M. C. Murphy, president of the Board of Health, has requested the Sanitary Department of the board to request the presidents of the street surface and elevated railways in all the boroughs of the city to fumigate the mats, rugs, etc., on their cars, and otherwise put the vehicles in such a condition that they will not be dangerous to public health. Col. Murphy was impelled to give this order on the strength of the report of several officers of the board, who became convinced that many persons contracted the grip in the street cars.

INSPECTING ELECTRICAL WIRING.—Deputy Commissioner Walton, of the Department of Public Buildings, Lighting and Supplies, has sent notices to all electrical contractors and electrical companies in Greater New York to the effect that before beginning work on any electrical installation in the Borough of Brooklyn they should apply for certificates on forms provided for the purpose. Whenever work of this sort is found after inspection to be satisfactory, certificates covering the same are issued. Electric lighting companies have been requested not to make and not to permit to be made connection with any electric wiring or fixture for which the contractor does not produce a certificate from the department.

A RAILWAY "KICKING MACHINE."—It would be strange indeed to find a street railway that could satisfy everybody that travels on its lines. Every well or poorly-regulated street railway has a complaint department, and in the case of the Metropolitan Street Railway Company, of this city, it is called by the employees the "kicking machine." Some statistics of this bureau of the Metropolitan company show that one passenger out of every 60,000 makes a "kick" about something. As the road carries an average of 600,000 passengers a day, an average of ten complaints is received, copied, filed, indexed, investigated and reported upon each day in the year. It is further found that 97 per cent. of the written complaints are wholly unintelligible, and that 50 per cent. are couched in inflammatory and profane language. A large proportion of the complaints fail to give the number of the car or the conductor, or even the line on which the alleged indignity was suffered. Women are much more effective "kickers" than men, and generally give more ample details concerning the time, place, car, conductor's number, etc. The largest number of complaints specify the failure of cars to stop for the complainants.

AUTOMOBILE STAGES ON FIFTH AVENUE.—It is reported that the Fifth Avenue Stage Company has been purchased by President Albert J. Elias, Henry Hart and Edward Lauterbach, of the Third Avenue Railroad Company, and that these gentlemen intend to institute radical improvements in the service on this line. Mr. Lauterbach is reported to have said that stages run by electricity or compressed air will be substituted for the lumbering vehicles now in use. Transfers from the Fifth Avenue stage line to all the lines of the Third Avenue Railroad system can be arranged. The stage line at present runs from Eighty-eighth Street south to Bleecker Street, and it has the right of extension down West Broadway to Canal Street, and along Canal Street to the North River, thus enabling the vehicles to reach the Desbrosses Street Ferry. It is stated that the Third Avenue Railroad Company hopes to get a franchise to run the automobile stages the entire length of Fifth Avenue. This would allow transfers to the cable road on One Hundred and Twenty-fifth Street. Representatives of various automobile systems are now actively engaged in impressing upon the Third Avenue people the advantages of their respective systems.

SOUTHERN NOTES.

EXTENDING CONDUITS IN WASHINGTON.—A hearing has been given by the District Commissioners on Senate Bill 4881, providing for the extension of electric lighting conduits in the District. The officials of the United States Electric Light Company and of the Potomac Electric Light & Power Company expressed their approval of the measure, and also expressed entire willingness that Congress should give the commissioners full discretion in the matter.

A NEW ELECTRICAL ENTERPRISE FOR RICHMOND.—The Richmond, Va., Council passed an ordinance on December 23 granting franchises to the Virginia Electrical Railway & Development Company. This opens the way for the establishment of one of the most important enterprises inaugurated in Richmond in recent years. The company, composed mainly of Richmond and Baltimore men, has ample capital, and proposes to go into the electrical business on an extensive scale. The plant will be located on a part of the Haxall Hills site, with a river front of a thousand or more yards. The electric company will use the water power of James River for the distribution of electric power, and conditional contracts have been made by a number of the largest manufacturing concerns here. Plans for the buildings, which, with machinery, will cost $300,000, have already been adopted.

BUFFALO AND NIAGARA FALLS NOTES.

THE ELECTROPATHY COMPANY, of Buffalo, has been incorporated, the directors being Alfred C. Scheu, Ellen Rodgers and Elbert Rodgers. The company will engage in the manufacture of electrical apparatus.

DEMAND FOR THE TELEPHOTOS.—The works of the Boughton Telephotos Company, in Buffalo, have received a Government order for ten new sets of this electrical signal apparatus. A letter from Commodore Marix states that the apparatus was found very efficient during the war.

THE BUFFALO FIRE DEPARTMENT is contemplating the changing over of its electric generating apparatus from primary cells to storage battery, but no decision has been reached as to the system to use. The work may be deferred till the headquarters building has been remodeled.

NIAGARA POWER IN BUFFALO.—The Buffalo General Electric Company has so far shut off about 1000 horse-power from the local plants and switched on Niagara power. The work has been carried on with great care, so that no outward evidence of the change has made its appearance.

NIAGARA POWER FOR A STEEL COMPANY.—The latest negotiations for power at Niagara is with a steel company that proposes to locate somewhere in the vicinity of the power house. As yet the proposals have not been carried far enough to warrant the company in giving out direct information in regard to it.

THE CANADIAN POWER FRANCHISE.—The Niagara Falls Power Company has won its case in court at Toronto against the people on that side of the line who were trying to obtain an annulment of the exclusive grant given to that company some years ago for the development of power from the falls. It does not appear that the opposition was in very active existence, for no move has ever been made to do any work. Plans were drawn and a good deal of talking was done. All that the Canadians are supposed to have undertaken was either to spur the company on or to drive it away, so that a new franchise could be obtained for sale to outside parties. The company set forth that for certain reasons beyond its control it was unable to develop the required 25,000 horsepower within the time specified. How long an extension was granted is not reported.

CHICAGO NOTES.

MR. M. B. WHEELER, secretary and treasurer of the M. B. Wheeler Electric Company, Grand Rapids, Mich., paid a visit to Chicago last week on his way home from an extended trip through the South. Mr. Wheeler, while in Chicago, closed several large and important deals in connection with the enlargement of his company's business.

WIRELESS TELEGRAPHY BEFORE THE CHICAGO ELECTRICAL ASSOCIATION.—At the regular meeting of the Chicago Electrical Association on December 16 Mr. Arthur Vaughan Abbott, chief engineer of the Chicago Telephone Company, delivered a lecture on "Wireless Telegraphy." His practical demonstrations with working apparatus were enthusiastically received by a large audience. Mr. Abbott has been experimenting and developing his apparatus during the past year, and now he has established communication between his office and residence, 2 miles distant. In the lecture the principles underlying wireless telegraphy were fully explained, with due credit given to Hertz, and other pioneers and later investigators, including Marconi. After the lecture the annual election of officers was held, with the following result: President, Thomas G. Grier; vice-president, J. M. Hollister; treasurer, Harold Almert; secretary, Cloyd Marshall; directors, F. S. Hickok, E. W. Jewell and Hayward Cochrane. The secretary's address is 1310 Monon Building.

INDIANA NOTES.

MUNICIPAL LIGHTING PLANT IN GREENFIELD.—The electric light plant at Greenfield has been transferred to municipal ownership by that city. Congressman Henry was the principal stockholder. The consideration was $26,000.

GRANT OF RIGHT-OF-WAY.—The Commissioners of Dearborn County have granted a right-of-way to the Cincinnati, Lawrenceburg & Aurora Electric line across the county. Under the grant electric cars must be running by November 1, 1899.

ARTICLES OF INCORPORATION have been filed by the Putnam County

Telephone Company, of Green Castle, with a capital stock of $10,000, to operate a plant and line in Putnam, Parke, Clay, Hendricks and Morgan Counties. The board of directors is composed of F. C. Gilmore, C. C. Hart and Jesse Richardson.

THE BUILDING OF AN ELECTRIC line from Hartford City to Franklin, thence to Lapel, Perkinsville and Indianapolis, is now assured, the several townships along the proposed route having pledged the required aid. The citizens along the proposed line are jubilant over the prospects and rights-of-way are readily secured.

AFTER A FIFTY-YEAR RAILWAY FRANCHISE.—Terre Haute capitalists are interested in a project and have asked for a fifty-year franchise for an electric line from Terre Haute to Mattoon, Charleston and Paris, Ill. The latter city has no street-car line, and the establishment of a local plant in connection with the line would be easily accomplished.

MAN AND WIFE GET A TELEPHONE FRANCHISE.—Wm. N. Turner and his wife, Emma B. Turner, have been granted a telephone franchise by the Common Council of North Vernon. Long-distance connection will be made. Business houses are to be charged $1.50, and residences $1 a month. Mr. and Mrs. Turner are being commended for their enterprise.

A NEW ELECTRIC RAILWAY.—Preliminary steps have been taken to build an electric line from Garrett, DeKalb County, to Auburn Junction, and thence to Ashley and Hudson. The project is meeting with opposition by business men in small towns through which the line passes, on the ground that people would have an opportunity to go to the larger towns to do their trading.

WISCONSIN NOTES.

A NEW PLANT FOR CHIPPEWA.—The Chippewa Valley Electric Railway Company, of Eau Claire, will put in a plant of its own, and will bid on the city lighting.

TO REPEAL AN ELECTRIC RAILWAY FRANCHISE.—An ordinance has been introduced in the Milwaukee Common Council repealing the franchise of the Waukesha-Milwaukee Street Railway Company, obtained some time ago through the efforts of John W. Wagner, but which has never been used.

ELECTRIC RAILWAY FRANCHISE IN KENOSHA.—John W. Wagner, the attorney, who obtained a street railway franchise from the Milwaukee Council a few years ago and never made any practical use of it, has, in behalf of the Kenosha Traction Company, applied for one from the city of Kenosha. A. C. Frost and Geo. H. Ball are building an electric line from Waukegan to Evanston, and Mr. Wagner proposes to build a line through Kenosha and a connecting link between that city and Waukegan. If he obtains the franchise and the line is built there will be a through line of electric cars from Milwaukee to Evanston. Mr. Wagner declines to state who is back of him financially.

INJUNCTION AGAINST THE DISPOSITION OF STOCK.—Edward E. Wagner has begun a suit against William J. Austin and the Milwaukee Rail Joint & Welding Company, and asks for an injunction restraining Mr. Austin from taking any action that will interfere with the work of the company. It is alleged that a patent rail-welding process of Mr. Austin's was taken up by the company under a contract by which Mr. Austin was to receive certain sums. Mr. Wagner, who secured a third of Mr. Austin's interest, alleges that if Mr. Austin were allowed to dispose of his alleged rights on the ground that certain portions of the transfer agreement had been violated the company would suffer loss.

ST. LOUIS NOTES.

THE STREET LIGHTING MATTER.—The Lighting Committee of the Board of Public Improvements is considering the question of not naming in the next bill any particular method of lighting the streets. The amount of light is to be specified in candle-power, and the constructor is to be allowed to use any method of light he selects provided he supplies the required amount.

ANOTHER ROAD SOLD TO THE HAMILTON SYNDICATE.—It is reported that the franchise of the Wellston, Creve Cœur Lake & St. Charles Railroad Company has been purchased by the Hamilton Syndicate through Charles F. Orthwein, and it is to extend the Easton American line over the St. Charles road to the Missouri River, where a bridge will be built to St. Charles.

NEW ELECTRIC ROAD.—Work commenced Wednesday on the new railway line of the Fenton & Southwestern Railway Company connecting the town of Fenton, St. Louis County, with St. Louis. The McCoy Construction Company is building it, and announces that the line will be ready for operation by May 1, 1899. The road will be 28 miles long and run through one of the most prosperous portions of St. Louis County. The stockholders are said to be largely prosperous St. Louis County farmers. Besides carrying passengers the road will make a specialty of fast freight cars, which will bring fruit and produce to the St. Louis market.

PACIFIC COAST NOTES.

THE COLUMBIA & NORTHERN TELEPHONE & TELEGRAPH COMPANY, of Colville, Wash., was recently incorporated, with a capital stock of $15,000.

THE SAN PABLO AVENUE cable road, Oakland, Cal., which is owned by the Southern Pacific Railroad Company, will soon be changed over to an electric line. The foundations have been laid for the enlargement of the Temescal power station, which is necessitated by the change. The new line will connect with the end of the Telegraph Avenue line, running via University Avenue. It is said that an electric branch line will be constructed on Park Avenue to the Oakland race track.

THE LOW-WATER DIFFICULTIES RELIEVED.—The recent rains in California have been of great advantage to the water-power electric transmissions of the State. The Sacramento Electric, Gas & Railway Company, which some months ago suffered from the unprecedentedly low stage of the American River near its generating station in Folsom with water, soon made arrangements to fill nearly all of its contracts. A large steam plant which was provided for in the original plans was finished in time to take care of a large part of the load while affected by the shortage of water. At no time were the patrons of the company seriously inconvenienced for any great length of time. The Fresno plant, which, also, is operated with General Electric apparatus, soon recovered to a great extent from the effects of the drouth.

CANADIAN NOTES.

MR. WALLABERG, of Montreal, has been in Ottawa negotiating with the Canada Atlantic Railway Company to have the new shops of the company which it is about to erect at Ottawa fitted up in a modern manner and similar to the shops recently completed at Sherbrooke, Que. There the power is supplied by electric motors. The Buffalo Forge Company's system of fans has been adopted for heating purposes.

THE METROPOLITAN ELECTRIC LIGHT COMPANY, of Ottawa, is now an incorporated body. Letters patent have been issued to the company, and extensive operations will begin at once to promote the building of the lighting plant. The canal for the development of the water power to be utilized will be 180 feet wide, 9 feet deep and 2000 feet long. The reservoir will extend up the lake for a distance of 30 miles, and will be 1½ to 3 miles wide and 40 feet from shore. The power house will be erected at the foot of the Deschene Rapids.

TO DEVELOP THE FENELON FALLS WATER POWER.—For some time past the town of Lindsay, Ont., has been trying to secure a cheap electric power. Culverwell & White-Fraser, of Toronto, undertook to form a company and transmit the power from Fenelon Falls to Lindsay, but were unable to make the financial arrangements necessary to the undertaking. The matter has now been taken up by some of the citizens of Lindsay. An electrical expert is to be employed to look into the subject, and if it is endorsed by him the plan will be carried through.

ENGLISH NOTES.

ANNUAL DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.—Over 250 members attended the annual dinner of the institution at the Hotel Cecil on December 7. After the usual loyal toasts had been duly honored, the Attorney-General proposed "The Institution of Electrical Engineers," and in the course of his speech said that the institution was an embodiment of the extraordinary development of the science of electrical engineering, whose practical application was contemporaneous with the Victorian era, and concluded with a tribute of praise to the President, Mr. J. W. Swan. In returning thanks, Mr. Swan stated that the electrical undertakings due to British capital had absorbed close on 100 millions sterling. The number of miles of electric railway and tramway in the world could be counted by thousands, the horse-power transformed into electric power by hundred of thousands, the miles of telephone and telegraph lines by millions and the incandescent lamps by tens of millions. "The Navy, Army and Reserve Forces" was proposed by the President and replied to by Admiral Sir W. J. L. Wharton, Gen. Sir Richard Harrison and Mr. R. E. B. Crompton, the latter as commanding officer of the Electrical Engineers Volunteers. This corps could, said Mr. Crompton, fill its ranks to-morrow, but its care must be to fill them with the right men. Mr. Crompton also alluded to the repulse of an attack, on Tesla's principle, in the upper regions of the atmosphere; in fact, Tesla's latest journalistic sensations afforded material for joke in nearly all the speeches.

OVERLOADED ELECTRIC LIGHT PLANTS.—The rapid increase to the number of connections to the electric lighting networks in our large towns, taken in conjunction with the rush of orders during the past two years on manufacturers of electrical plants, has resulted this winter in a most serious overloading and consequent drop of pressure in many districts. In Edinburgh a circular from the corporation electricity works had to be sent out to all consumers, asking them to use as little light as possible during the hours of heaviest load, as, owing to the contractors having failed to deliver the necessary machinery, the plant was considerably overloaded, and pressure could not be kept up during certain hours of the evening. By strenuous exertion on the part of the engineer and his staff temporary arrangements have been made by which the pressure has now reached its normal value at Edinburgh. At Manchester, however, some of the plant which was ordered as long ago as October, 1897 (during the engineering strike) is not yet running. Relying on the assurances of the contractors that the plant would be delivered by the end of the summer, a very large number of consumers were connected to the mains this year, with the result that during the last fortnight the pressure has at times dropped from 100 to 87 volts. Glasgow is in a similar predicament, through delay in erecting a new generating station there. Here the course has been adopted of only connecting new consumers on the understanding that the supply to them might have to be discontinued, so that a serious lowering in the pressure has been avoided in that town. Last, but not least, during the last few days in the city of London the pressure has occasionally dropped to a very low value between 4 and 5 in the afternoon and during fogs, the lowest recorded being 85 volts. Here the cause is the non-delivery of steam pipes, which have been on order since last August. Sufficient machinery is in place and running, but only two out of five boilers recently erected can be used, and consequently the steam pressure could not be maintained at times of full load.

ELECTRIC LIGHTING IN THE CITY OF LONDON.—A libel action brought by Sir Joseph Savory against the proprietors of a paper called "London" has aroused considerable interest in the electrical world. It will be remembered that when the electric lighting of the city of London was first decided on, the city was divided into three districts, and contracts were awarded to the Brush Electrical Engineering Company for two of these

districts, and to Messrs. Lang, Wharton & Down for the third. This happened to be just about the time of the Baring crisis, and the contractors found it extremely difficult to obtain the large capital necessary to undertake a work of this description. There was, in consequence, danger of the provisional orders lapsing, owing to the work not having been commenced, when a group of financiers calling themselves the City of London Pioneer Company bought the contracts and the provisional orders from the firms in question, and succeeded in floating the City of London Electric Lighting Company, which at present provides the city with both public and private lighting. The result of this deal was, of course, considerable profit to the Pioneer Company and its promoters, which, in spite of the financial risk incurred, some people considered to be excessive. Sir Joseph Savory, who was then Lord Mayor, and, in consequence, ex-officio Chairman of the Commissioners of Sewers, who awarded the contracts for electric lighting, had a considerable interest in the Pioneer Company, and an article in "London," published last June, commented adversely upon the part Sir Joseph had then taken, referring to the transaction as very discreditable, and combining the characteristics of Hooleyism and Tammanyism. It was, stated the article, one of the worst jobs which had tarnished the municipal history of London. Sir Joseph Savory naturally brought a libel action against the paper, but as a result it was declared that the facts stated were true, and that the comment was made in good faith and without personal malice. Mr. Justice Day, in summing up, stated that while there was no reason to think that Sir Joseph Savory had not acted in an honorable manner, yet there was no doubt that he had been extremely indiscreet. This action is of special interest at the present time, as no less than three companies who are lighting other parts of London, viz., the Metropolitan Electric Supply Company, the Charing Cross & Strand Electricity Supply Corporation and the Smithfield Markets Electric Supply Company, have applied to the Corporation of London for the necessary permission to enable them to acquire provisional orders, and it has been refused. The agreement, in fact, between the city authorities and the City of London Company makes the refusal necessary until 1911. The Charing Cross & Strand Electricity Corporation are, in the meantime, circulating an enormous petition of ratepayers in favor of consent being given to their desired provisional order, this petition having been signed by 5,000 ratepayers, and the final result of the movement is being awaited with interest.

French Notes.

SAD DEATH OF M. DE MERITENS.—Another name has been added to the roll of martyred inventors. M. de Meritens, well known in Paris and to the scientific world by reason of his numerous inventions and especially for his apparatus for lighthouses, killed himself in despair after the sale of his furniture, at Eragny-Neuville, near Pontoise. The unfortunate inventor fell into want and was without shelter. His wife committed suicide at the same time, both taking poison. M. de Meritens was 65 years of age and his wife 35.

MESSAGES BY TELEPHONE.—M. Mongeot, Under-Secretary of State for Posts and Telegraphs, has matured a plan for the extension of the telephone service. This plan contemplates the notification of any person, whether renting a telephone or not, that some one wishes to talk with him at a given public telephone booth. The message will be carried to the recipient's house like a telegram. Within a radius of twenty-five kilometres the charge will be 5 cents, and must be paid by the sender of the message. The charge will be increased for any distance over twenty-five kilometres, but will in no case exceed 10 cents. The message will be a regular form somewhat as follows: "You are notified that Mr. X, living at ——, requests that you will come to telephone booth No.—— at—— o'clock." Each message will be numbered in the order of its receipt, and the number will entitle the recipient to the use of the booth at the time specified. It will be possible to avail one's self of this new arrangement only at stated hours in the day.

THE EXTINCTION OF THE BULLIER PATENTS IN GERMANY.—The Berlin patent office has recently declared the Bullier German patent to be void. This patent was taken out in 1894 by a French chemist, an assistant of Professor Moissan, on the only known practical process for making calcium carbide by heat generated electrically. This patent is owned in Germany by a company, which is controlled by the General Electric Company, and owns an aluminum manufacturing plant at Neuhausen and an electro-chemical plant at Bitterfeld. Owing to the unwillingness of this company to permit the manufacture of calcium carbide under license this patent has been a great obstacle to the introduction of the acetylene light in Germany. The recent action of the patent office will doubtless soon be followed by a substantial reduction in the price of calcium carbide. This process was invented in exactly the same way in America by Willson, who took out patents in 1884 in England and the United States. But even these patents seem shaky, as it has been proved that Borchers, a German scientist, was the first successful experimenter in the electro-thermic production of calcium carbide nearly ten years previously. The latter made no attempt to utilize his invention in a commercial way. However, it seems likely that the imperial patent office was influenced by the foregoing work in making its decision. Suit has been brought in France on the same point, in the interests of the French industries, by M. Raymond Poincaré, ex-Minister of Public Instruction, acting on behalf of the Société des Forges against M. Moisson.

THE COST OF ELECTRICITY FOR LIGHTING.—In Brussels, Belgium, the charge made for current is 12 cents per kw-hour. The legal price is 14 cents, with a discount of 20 per cent. to consumers whose bills exceed $700 per year. A few favored customers pay 10 cents, but the lighting companies do not admit it. In Berlin, where electric lighting industries are very prosperous and the current is generated in stations similar to the Lyons Railway Central Station, the price is 14 cents per kw-hour, subject to discounts ranging from 5 to 50 per cent. The price for city lighting is 6 cents per kw-hour, and even this low price is subject to some reductions. The company of the Falls of the Rhine (Rheinfelden) charges 10 cents per kw-hour, and makes discounts reaching as high as 80 per cent. At Altoona (Belgium) the price per kw-hour is 20 cents; at Breslau (Silesia) 18 cents; at Frankfort, 18 cents; at Hamburg, Munich, Nuremberg, Strasbourg, 14 cents. These prices are all subject to discounts. The average price of 14 cents per kw-hour puts the cost of a lamp hour at 0.8 cents. In England the rates are even better. At Birmingham the price is 14 cents per kw-hour; at Edinburgh, 12 cents, and at Liverpool 14 cents. In London, where gas is 56 cents per 100 cubic feet, the cost of a kw-hour ranges between 10 and 16 cents. At Manchester the price is 4 cents per kw-hour, the lowest price known. In France the cost of electric light is increased 50 per cent. by taxation. The best situated towns as regards price are Nancy, where it is 12 cents per kw-hour, and Saint Etienne, where it is 14 cents. At Havre 16 cents is paid per kw-hour; other towns have to pay 22 cents and 24 cents per kw-hour.

ELECTRICAL "HYDRANTS" FOR AUTOMOBILES.—A commission selected from the Electrical Industries Association, the Engineers' Club, the Automobile Club and the Electrical Manufacturers' Association has drawn up a set of specifications to govern a competition for a prize of $80, to be awarded to the designer of the most satisfactory electrical "hydrant," or supply box, from which automobiles may be recharged. Each person desiring to enter the competitions must send his apparatus, accompanied by a full description, to the "President du Syndicat Professionel des Industries Electriques, Hotel des Ingénieurs Civil, 19 Rue Blanche, Paris, before March 1, 1899." The apparatus will remain the property of the designers, but the commission reserves the right to publish descriptions and to put the hydrants on exhibition. Neither the apparatus nor the accompanying description should bear the name of the inventor, but simply some distinguishing mark, the name and address of the inventor being enclosed in a sealed paper sent with the description. Requirements: The box itself must be made for out-of-town use, and arranged so that the contents will be protected from the weather and from accidental short circuiting. It must contain: First, a voltmeter, with pole changer, to read the voltage and polarity of both supply terminals and battery; second, a wattmeter; third, a rheostat and double pole switch; fourth, universal supply terminals, with cables having two conductors (each conductor must have the same kind of junction piece on each end, but the junction pieces of the two conductors must differ); fifth, everything connected with the supply box must be designed to stand 70 to 80 amperes at 120 volts; sixth, the whole box must be designed as compactly as possible, and must be perfectly insulated; seventh, the selling price of the entire outfit and of the single terminals must accompany each apparatus. The designer may make any additions he pleases, so long as the conditions of the competition are all met.

THE ELBEUF ELECTRIC STREET RAILWAY SYSTEM.—The tramway system of Elbeuf, which has recently been opened for traffic, is the sixth railway to be equippped with electricity by the General Tractions Company. Elbeuf is one of the chief manufacturing towns of Normandy. It has numerous thread, cloth and woolen mills and novelty factories. The city is very much drawn out, being about four miles long by one and a half wide. The centre of the town is about a mile and a half from the Saint-Aubin depot. The industrial activity forces the inhabitants to travel constantly. Workmen, factory hands, clerks, drummers, dealers and consumers must go from one part of the city to another according to the necessity of their business. Up to the present this busy hive has been utterly without any system of either rapid or economical transit. The company operates about six miles of railway in two lines, one running the length of the city and the other running across the city. The system is double tracked and the two trolley wires are bonded together every 1,500 feet. A feeder runs from the switchboard to the Rue des Traités, and feeds into the trolley near Calvary Square, where the two lines cross. The feeder has a figure-8 section and is split in the middle at the end, each half being soldered to one of the trolley wires. The drop in voltage to various parts of the line may be read at the stations by means of pilot wires. A return cable is laid from Calvary Square back to the station in a trench filled with asphaltum. This cable is in four strands, each strand being bonded to one of the four rails. On the bridge it was necessary to make special construction to secure good insulation. The Dickinson system of trolley suspension is used at Elbeuf. The great adaptability and superiority of this system in tortuous streets and sharp turns often met with in small cities is well established. The rolling stock comprises twelve motor cars and five trailer cars. Each car is equipped with two 25 horse-power motors, and is divided into first and second class compartments by a movable partition. There are eighteen second-class seats and six first, and room for ten more on each platform, making a total capacity of forty-four passengers.

General News.

New Incorporations.

THE PINE BLUFF ELECTRIC LIGHT & STREET RAILWAY COMPANY, Prescott, Ariz., has been incorporated.

THE LEXINGTON TELEPHONE COMPANY, Lexington, Tenn., has been formed with a capital stock of $200,000. The incorporators are J. E. Meleall, H. E. Gruper, E. J. Timberlake, C. G. Gathing and W. T. Watson.

THE COLUMBIA TELEPHONE COMPANY, Columbia, Mo., has been incorporated, with a capital stock of $5000. The incorporators are James A. Hudson, Julia A. Hudson, Ethel A. Hudson, Macon; E. W. Stephens and A. W. McAllister, Columbia.

THE SPRINGFIELD TELEPHONE COMPANY, Springfield, Ohio, has filed articles of incorporation with the Secretary of State at Columbus. The company is backed by I. Ward Frey, Robert C. Gotwald, C. H. Pierce, E. C. Gwynn and Robert Mills. Capital stock, $50,000.

THE COLUMBUS CITIZENS' TELEPHONE COMPANY, Columbus, Ohio, has been incorporated with a capital stock of $500,000. The incorporators are H. D. Critchfield, E. R. Sharp, J. B. Hanna, J. B. Hoge, F. A. Davis, W. A. Hardesty and H. A. Landman.

THE PENNSYLVANIA TELEGRAPH & TELEPHONE COMPANY, Beaver, Pa., has been formed by Stephen P. Stone, Daniel H. Stone and Charles H. Stone, of Beaver, and H. C. Patterson, H. H. Patterson and James P. Stone, of Beaver Falls, for the purpose of consolidating the independent lines operating in New Castle, Youngstown, Butler, Erie and down the Ohio River as far as Wheeling, including Hookstown, East Liverpool, Wellsville and Steubenville.

THE INTERURBAN RAILWAY COMPANY has been incorporated at Westchester, Pa., for the purpose of building an electric road from Philadelphia to Lancaster by way of Williston Inn, Westchester, Unionville and Quarryville to Lancaster. The officers of the company are as follows: President and general manager, Winslow Mason; vice-president, John A. Heaney; secretary, M. E. Gibson; treasurer, H. E. Hiles; chief engineer, W. T. Forsythe; and the directors are Thomas Bromley, H. W. Lambirth, S. M. Hess, J. Preston Thomas, Dr. G. Morris Philips, S. W. Smith, M. E. Gibson, C. T. Shields, William Garrett, A. F. Johnson, Charles O. Beaumont, M. S. Way, I. G. Le Fevre, W. Mason and W. M. Franklin.

THE TELEGRAPH AND TELEPHONE.

TIFFIN, OHIO.—The Home Telephone Company has completed its line to Berwick, McCutchenville and New Riegel and until January 1 will give free service to all of its patrons.

WASHINGTON, D. C.—A bill has been introduced in the House having for its object the prohibition of the use of telegraph and telephone lines for the purpose of lottery and horse-race gambling. The bill was considered by the House Judiciary Committee on December 16.

UTICA, N. Y.—The Central New York Telephone & Telegraph Company has purchased some property on Bleecker Street, in this city, on which it proposes to erect a steel-frame building six or seven stories high. The new structure will be mostly occupied by the exchange and offices of the company.

OMAHA, NEB.—The Iowa Telephone Company has had a large force of men at work on the new private telephone of the Cudahy Packing Company between Sioux City and Omaha, which is now in operation. General Manager Frazee said this new service would be of great advantage to the company.

GREENVILLE, PA.—A deal has been consummated whereby the independent telephone companies of Mercer, Lawrence, Butler, Erie, Crawford and Beaver Counties, in Pennsylvania, and in Turnbull County, in Ohio, are to be interconnected. The work of making the connections will be commenced at once.

LAKEWOOD, N. J.—The Delaware & Atlantic Telephone Company has made application for a franchise through the borough of Point Pleasant. An ordinance has been introduced and a public hearing will be given upon it. It is said that the proposed line will run from Point Pleasant to Lakewood, Toms River, Mount Holly and Philadelphia.

PEORIA, ILL.—The Central Union Telephone Company has decided upon and will put in force a new schedule of rates for telephone service in the city of Peoria. The new schedule provides for a reduction of from 10 to 33 1-3 per cent. For distances of one mile or less a reduction of 10 per cent. is made, and the reduction continues until for two miles or more the reduction is 33 1-3 per cent.

SAN FRANCISCO, CAL.—Prof. Albert Vandernaillen, who has been making some experiments here with wireless telegraphy, claims to have achieved some extraordinary results. It is stated that messages were transmitted with accuracy, and the sharpness of the characters on the sounder are said to have been very good. At recent trials of the apparatus the sending and receiving instruments were placed at a distance of several hundred feet apart.

COLUMBIA, MO.—The proprietors of telephone exchanges in Missouri met at Glasgow recently and organized the Missouri Independent Telephone Association. About thirty exchanges were represented. A committee consisting of the chairman and secretary and Theo. Gray, of Macon; E. D. Graham, of Mexico, and D. F. Vincent, of Slater, was appointed to report a form of constitution and by-laws at the next meeting, to be held in St. Louis December 27.

LAFAYETTE, IND.—The Bell Telephone Company has, it is reported, been endeavoring for some time to get the control of the Western Indiana and the Jasper County Telephone companies, which control a large number of exchanges and many miles of toll lines. At a recent meeting the Bell proposition was considered and rejected, and a twenty-five year contract was entered into with the Lafayette Independent Telephone Company and the new long-distance telephone company of Indianapolis.

URBANA, OHIO.—The Urbana Telephone Company held its first annual meeting and elected a board of directors and permanent officers. The following gentlemen were elected members of the board of directors: James B. Johnson, J. I. Blose, C. H. Marvin, J. C. Powers, D. B. McDonald, J. H. E. Dimond, Edwin M. S. Houston, Ed. L. Barber and James Brailey, Jr. The board then organized by electing the following officers: James B. Johnson, president; J. H. E. Dimond, vice-president; C. H. Marvin, secretary; John C. Powers, treasurer. It was decided to continue the line to Westville as far as St. Paris, and a number of other improvements were considered. The report of the secretary showed that the company had 257 subscribers, with prospect of 300 by the first of the year.

BOSTON, MASS.—It is stated that the Western Electric Telephone Company has purchased the charter of the Standard Telephone Company in Missouri, and is building a system of toll lines in that section of the country in opposition to the Bell company. Ex-Governor Thomas F. Crittenden is president of the new Standard Telephone Company, and Charles Webster is vice-president and general manager. The company's capital is $300,000, which is issued as the lines are built. Up to the present time it is stated that 980 miles of lines have been completed and material for 80 additional miles is on the ground. The new company has started to build a trunk line from Kansas City to St. Louis, connecting independent exchanges in those cities. The construction is similar to that in the Northwest, namely, 35-foot poles in cities, 25-foot poles in the country, and twenty-five to thirty poles to the mile. Nos. 9 and 10 wire are used for the lines.

COLUMBUS, OHIO.—The Co-operative Telephone Company, of this city, has elected officers and subscribed the necessary 10 per cent. of the stock, and has completed all preliminaries to the active work of putting in the new plant as soon as the City Council and Board of Public Works gives permission to use the streets. The following directors of the company were elected: Captain Alfred E. Lee, George Riddle, George D. Jones, O. B. Summers, O. H. S. Eberly, M. L. Boyd, W. B. Childers, Charles F. Galloway, Moses B. Earnhart, W. M. Payne, Justus Herrick, Charles W. Grau, J. B. Shook, J. F. Fergus and G. D. Owens. After the election of the board of directors the directors held a meeting and elected the following officers: Geo. D. Jones, president; Alfred E. Lee, vice-president; Frank H. Howe, secretary; Charles A. Spenney, treasurer.

THE PACIFIC CABLE PROJECT.—A bill was introduced in the national House of Representatives on December 20 to secure the construction and laying of a cable between the United States, Hawaii, the Philippines, Japan and China. It appropriates a sufficient sum to provide a cable that will carry at least fifteen words a minute, and when the cable is completed it shall be turned over to the Post Office Department and operated as a part of the postal service. Private messages may be transmitted at a rate to be fixed by the Postmaster-General, not exceeding one dollar a word, press messages to be carried at half rates. All receipts of the cable service in excess of the cost of operation shall be deposited in the treasury. Representative Corliss, of Michigan, who introduced the bill, has called the attention of the Secretary of State to the fact that the Scrymser concession for a Pacific cable will become binding, and give the Pacific Cable Company exclusive rights to land cables on Hawaiian soil for twenty years, unless the department interferes before January 2 next. Bills are now pending in both houses of Congress granting aid to the Pacific Cable Company, which now owns the Scrymser concession.

ELECTRIC LIGHT AND POWER.

MONCTON, N. B.—Extensive changes will probably be made in the electric light plant of this town.

MITCHELL, ONT.—The ratepayers have defeated the by-law to raise $5000 by debentures for the purpose of improving the electric light plant.

BINGHAMTON, N. Y.—The Binghamton General Electric Company has declared a semi-annual dividend of 2 per cent., payable on January 2 next.

ACTON, ONT.—The ratepayers have sanctioned the by-law to provide $6000 for the purchase of an electric light plant. Arrangements will be made immediately for the installation of the plant.

MUNCIE, IND.—The electric light plant power house, owned by the city, was damaged to the extent of $3000 by an explosion of natural gas on December 16, and Superintendent William Warner probably fatally injured.

SHERBROOKE, QUE.—The North Hatley Electric Light Company has purchased the water power on the Magog River, which it will utilize in driving electric generators for the purpose of supplying light and power to this city.

HALIFAX, N. S.—The city electrician and engineer have been instructed to prepare plans and invite tenders for a city electric light plant. This action is the result of a report of a special committee which investigated the subject of municipal lighting.

DAYTON, OHIO.—The contract with the Dayton Electric Light Company, under which the city is paying $100 per year for each street light, expires on November 24, 1899. The Independent Light, Heat & Power Company has been organized for the purpose of building and operating an electric light plant in the city, and desires to secure a franchise so that it may be in position to bid for the city lighting when the present contract expires.

CANANDAIGUA, N. Y.—On October 7 last Mr. M. D. Munger applied to the Board of Trustees of Canandaigua for an electric lighting franchise. After careful consideration of the subject the trustees declined to grant the petition on the ground that the present company, the Canandaigua Electric Light & Railroad Company, was giving good service, and that it was not for the best interests of Canandaigua to give another franchise.

BRIDGEPORT, CONN.—The Housatonic Power Company has given notice that it will petition the General Assembly for an amendment to its charter giving it the right to build a dam across the Housatonic River between the towns of Bridgewater and Brookfield, at or near the village of Southville, and the right to conduct electricity from New Haven County to points within Hartford County. It is the intention of the company to obtain power from the waterfall to be created by the construction of one or more dams for the purpose of generating electricity.

THE ELECTRIC RAILWAY.

CINCINNATI, OHIO.—A stock company was organized here, with a capital of $500,000, to build an electric road from Cincinnati to Lebanon, a distance of 25 miles.

EASTON, PA.—The Easton, Palmer & Bethlehem Electric Railway Company will carry mail between Easton and Bethlehem and the intervening towns along its road. There will be two dispatches each way daily except Sunday.

PERKASIE, PA.—The Borough Council of Perkasie has passed an ordinance giving the right-of-way in the town to the Inland Traction Company, which proposes to construct a trolley line from Perkasie to Lansdale. The company must give a bond of $10,000 to complete the line within a year.

CINCINNATI, OHIO.—The Cincinnati Street Railway Company is preparing to adopt improvements in the operation of the Cincinnati street cars. Superintendent John Harris is making a tour of Eastern cities, including New York, Boston, and Philadelphia, for the purpose of noting any improvements which will be an advantage to the public here.

TORRINGTON, CONN.—The Torrington & Hartford Tramway Company gives notice that it will apply to the General Assembly for a petition to extend its line southward from the east branch in Torrington to East Litch-

field and westward from there to Bantam Lake. The company also intends to build a line from the Centre Bridge, in Torrington, to run along the Litchfield road, intersecting with the first named line at a convenient point.

NEW YORK, N. Y.—President Johnson, of the Nassau Electric Railroad Company, of Brooklyn, has given orders for the withdrawal from service of the so-called "coffin cars" on that line, to which so much objection has been recently raised by the traveling public. The name "coffin" was applied to the combination cars introduced on the Nassau lines. These cars have side doors, and while they were not objectionable in warm weather, they were decidedly so in cold weather.

HARTFORD, CONN.—A petition to the General Assembly has been filed praying for a charter for an electric street railway to run between Somers and Enfield and to be called the Enfield & Somers Electric Railway Company. The company also desires to supply electricity and electric light in the town of Somers and the villages of Hazardville and Scitico. The petition also asks that any other corporation may be permitted to subscribe to the stock of the road, and that the towns of Enfield and Somers may be allowed to subscribe to the stock to an amount not to exceed $15,000 in each case. The petition is signed by George E. Keeney, James W. Wood, R. Keeney, L. Keeney, A. E. Brainard and James A. Thompson.

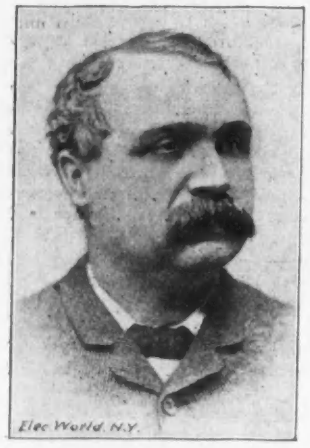
POTTSVILLE, PA.—Work will be commenced shortly on a trolley line between Phœnixville and Spring City, which eventually is expected to be continued to Limerick Square, and then to Pottstown. The part between Phœnixville and Spring City, a distance of six miles, will probably be put in operation by May next. The right-of-way has been secured almost the entire distance, and application will be made to the Councils of Spring City and Royersford next month for street rghts. John J. Ridgway, of Philadelphia, is president of the Montgomery & Chester Electric Railway Company, which will build the road. A charter for this road has been granted in Westchester. Mr. George F. P. Wanger is one of the promoters of the enterprise.

NIAGARA FALLS, N. Y.—It has been definitely decided to carry forward the winter carnival scheme and erect an ice palace in this city. The three trolley lines centering here and the line on the Canadian side of the river have offered very liberal encouragement to the project. The Gorge road offers to give $100 toward defraying the expenses and also 5 per cent. of the gross receipts during the existence of the palace. The Niagara Falls & Suspension Bridge Street Railroad Company will subscribe $100 and give 10 per cent. of the local business realized during the same period. The Niagara Falls Park & River Railway offers 5 per cent. of its gross receipts, and the Buffalo & Niagara Falls Railway offers to sell coupon tickets with an admission to the palace at the regular railroad fare.

AKRON, OHIO.—The new company which is to take over the property and business of the Akron Street Railway & Illuminating Company will be capitalized at $2,000,000, and it is stated that it will at once begin making permanent improvements. Practically the entire system will be rebuilt, and new cars and equipments will be ordered at once. The property of the old company has been appraised at $932,000. The present outstanding bonded indebtedness amounts to $1,200,000. One-half of this amount, or 6000 bonds, will, it is stated, be wiped out, and nothing will be paid on these. The present bondholders will be given 5 per cent. stock to the amount of $600,000 in place of the amount of bonds now held. It is reported that in addition to this bonds to the amount of $300,000 will be issued to provide for improvements.

OBITUARY NOTES.

MR. RONALD TREVOR McDONALD, president of the Fort Wayne Electric Corporation, Fort Wayne, Ind., and one of the most widely-known men in the electrical manufacturing business, died suddenly of pneumonia in Dallas, Tex., on the morning of December 24. Mr. McDonald was born in Allegheny City, Pa., on June 24, 1849. He was of Scotch descent, but of American parentage. During the civil war he was a drummer boy, and after his military service he returned to Fort Wayne, and entered business as a clerk in a dry goods store, afterwards becoming a partner in the firm of Evans & McDonald, wholesale dry goods merchants. In 1881 he, with other gentlemen, incorporated the Jenney Electric Light Company for the manufacture of electric lighting apparatus in Fort Wayne under the Langley patents. He was general manager and leading spirit of this concern. The Jenney patents were bought in the spring of 1882, and on October 2 of the same year the manufacture of lighting apparatus was begun on a small scale. Nothing but the enthusiasm, confidence and tenacity of purpose of Mr. McDonald carried the infant industry through its fight for existence in the early days of its history. Larger quarters were soon necessary, and the business expanded under his guidance. Mr. McDonald arrived in Fort Wayne from New York about two weeks ago, where, while attending to business, he was suddenly taken ill. It proved to be a slight attack, however, and he returned to his home in Fort Wayne, where he remained a few days before going South to attend to some business matters. It is stated that he remarked to one of his friends before leaving for the South that he never felt so averse to going anywhere as he did to Dallas at that time. On Wednesday, December 21, the news of his serious illness was received in Fort Wayne, and on the next morning Mrs. McDonald, in company with Dr. W. H. Myers, the family physician, left for Dallas. Between that time and until his death encouraging news was received as to the condition of the patient. The news of his death was therefore a profound shock to his friends. The remains were buried in Fort Wayne on December 27.



R. T. McDONALD.

Mr. McDonald was happily situated in his domestic relations. He was married in 1876 to Miss Lillie Morse, of Angola, Ind. The deceased was a very genial, hospitable man, and although his varied business interests occupied the greater part of his time what little opportunity he had for social intercourse he loved to spend in the company of his friends. He was a member of prominent clubs in New York, Chicago, New Orleans and Fort Wayne, and was a Freemason of high degree. Among the electrical interests with which Mr. McDonald was connected, besides the Fort Wayne Electrical Corporation, may be mentioned the Fort Wayne Consolidated Electric Railway Company; the electric railway and lighting company, of Ironton, Ohio; the electric light company at Dallas, where he met his death; an electric railway at Houston, Tex.; the Broad Ripple & Indianapolis Electric Railway; electric railways at New Orleans, and many others throughout the country. Mr. McDonald's fidelity to his friends was one of the principal traits of his character. He was a manly opponent, intense, aggressive and progressive, and necessarily these meet with opposition. He expected it, however, and he had no fear; he was never deterred from doing his duty as he saw it. THE ELECTRICAL WORLD is informed that from present indications Mr. McDonald's death will have no effect whatever upon the affairs of the corporation of which he was the head.

DR. WELLINGTON ADAMS, of St. Louis, Mo., who came into prominence in 1892 through his scheme to build a high-speed electric railroad between St. Louis and Chicago, died at his home in that city on December 19, of pneumonia. Dr. Adams was born in Brooklyn, N. Y., in 1856, and was, consequently, forty-two years of age.

MR. FREDERICK CULVER WHITMORE, of the railway engineering department of the General Electric Company, died, at the early age of twenty-six years, of typhoid fever at his home in Hartford, Conn., on December 7. Mr. Whitmore began his career with the Thomson-Houston Company on the "students' course" at the Lynn factory, from which he was advanced to the power and mining department, where he was engaged chiefly in design. In 1894 he was transferred to the Scranton, Pa., office of the General Electric Company, where he was general consulting engineer in power and mining work till 1898, at which time he returned to the home office in Schenectady. His work at Schenectady was wholly with the railway engineering department, in which at the time of his death he was filling with conspicuous success an important post in connection with the design of special railway apparatus. Mr. Whitmore was a man of uncommon gifts, and possessed unlimited energy and enthusiasm in his work. He had, beside, a manly and straightforward character and numerous qualities of personal charm which won him friends and gained him universal esteem.

PERSONAL NOTES.

PROF. ALEXANDER GRAHAM BELL arrived in San Francisco on December 26 in the steamer "China" from Japan and China. While in Japan Professor Bell received many attentions at the hands of the Japanese.

MR. HIRAM PERCY MAXIM, mechanical and electrical engineer of the Pope Manufacturing Company, Hartford, Conn., was married on December 21 to Miss Josephine Hamilton, daughter of the late Governor Hamilton. The ceremony took place at Hagerstown, Md.

Trade and Industrial Notes.

THE GARRETT BUILDING, Chicago, is to have an electric plant designed on the Arnold system. The Ball Engine Company, of Erie, Pa., will furnish therefor one 250-hp and one 175-hp engine.

THE HOUSE OF CORRECTION, Baltimore, Md., has recently started up a direct-connected plant which consists of generators of the Fort Wayne Electric Corporation direct-connected to two 60-hp engines built by the Ball Engine Company, of Erie, Pa.

THE VICTOR TELEPHONE MANUFACTURING COMPANY, 166-174 South Clinton Street, Chicago, has sold to the Chequamegon Telephone Company, of Ashland, Wis., a full 400-number exchange, including everything in the way of telephone equipment.

THE CENTRAL ELECTRIC COMPANY is receiving many flattering compliments from the trade on its new general catalogue. The catalogue contains a quantity of valuable data outside of the merchandise illustrated, and is worthy of careful examination and preservation.

MR. JOHN S. NOWOTNY is now established at 313 West Second Street, Cincinnati, Ohio. In addition to furnishing the Nowotny semi-vacuum, long-burning inclosed arc lamp, of which he is the inventor, Mr. Nowotny carries standard makes of dynamos and motors for all purposes and other electrical specialties.

MR. EDWARD P. THOMPSON, solicitor of patents, 81 and 83 Fulton Street, New York, has issued a pamphlet on the subject of obtaining patents by mail. Mr. Thompson has associated with him Mr. Alfred C. Coursen as associate legal counsel, and Prof. William A. Anthony as associate technical counsel.

THE BALL ENGINE COMPANY, of Erie, Pa., has contracted to supply two tandem compound engines of 165 horse-power each for the Norfolk Navy Yard, at Portsmouth, Va. The engines will be direct-connected to two 60-kw General Electric Company generators, and the new equipment will go in the extension of the Navy Yard plant.

RAW SILK WIPERS.—The American Silk Manufacturing Company, 311 Walnut Street, Philadelphia, has published a leaflet containing endorsements from a variety of industrial concerns regarding the satisfaction given by the use of raw silk wipers on machinery. Among the testimonials is one of the

John Stephenson Company, Limited, in which it states that these silk wipers have been used by that concern for over three years, and they have been found to be satisfactory.

MR. DUNCAN BOND, Denver agent for the Ball Engine Company, of Erie, Pa., has closed a contract with the Mountain Electric Company, in Denver, covering the engines for the electrical plant of the new Arapahoe County Poor Farm buildings. The Mountain Electric Company, acting as district manager for the Westinghouse Electric & Manufacturing Company, has contracted with the County Commissioners to furnish the necessary electrical and steam equipment. The units will be direct-connected and of the latest types of the respective makers.

THE LOMBARD WATERWHEEL GOVERNOR COMPANY, 61 Hampshire Street, Boston, Mass., reports that the demand for its governors is constantly on the increase. During last month orders were received for upward of twenty governors to regulate forty-one waterwheels, which will develop 15,750 horse-power. More than half of this machinery will be used in electric stations—principally in power transmission plants and electric railway stations—the balance being in textile and other manufacturing plants driven by water power.

THE MASON TELEPHONE PAY STATION COMPANY, Ludington, Mich., has in preparation a new catalogue to be ready about February 1, which will give full information as to the styles of prepayment instruments manufactured by this concern and details of their use. This catalogue will be very attractive, and anyone desiring a copy may forward an order to the office of the company at Ludington, and as soon as the catalogue is ready for distribution a copy will be sent. The Mason Company manufactures portable, soundproof booths and various styles of pay-station signs as well as automatic prepayment instruments.

THE WATSON-STILLMAN COMPANY, 204-210 East Forty-third Street, New York, has issued an illustrated index which is intended to show the large variety of tools manufactured by that concern. Each illustration represents from one to about twenty sizes of tools, a full and complete description of which is kept by the company in the form of loose sheets for distribution as required. The catalogue includes machinery and tools for a great many lines of business. This index, which is also known as Catalogue No. 51, will no doubt be found very convenient to those interested. The company expects soon to issue Catalogue No. 52, which will be devoted to street railway appliances. It intends to issue these special or group catalogues at frequent intervals, a dozen different ones being laid out at the present time for future issue.

IRONCLAD DYNAMOS AND MOTORS, generating sets, etc., constitute the subject of Bulletin No. 127 just issued by the C & C Electric Company, of New York. Perspective views and dimensional diagrams of the various machines of the enclosed type are given, together with a brief description of their construction. The electric hoist with open-type ironclad motor, the electric drill cutter equipped with special type C & C ironclad motor, and generating sets with open-type, ironclad dynamo and Forbes engines are also illustrated and briefly described. A direct-connected generating set with closed-type, ironclad dynamo and Case engine is shown. The improved C & C reaction brushholder, C & C automatic starting box and C & C field regulator are also illustrated.

THE NEW NO. 44 TRANSMITTER of the Eureka Electric Company, 157 South Canal Street, Chicago, Ill., is claimed to be unequalled for volume of tone and clearness of articulation. It is also attractive in design and symmetry, and it is of the best construction in every particular. The diaphragm is of metal, no other substances being employed in its construction other than carbon and metals. It is of the solid-back type, full nickeled, and is built to be mounted either upon the magnetic box or on long-distance arms. It is claimed that packing with this instrument is impossible, and the company guarantees each transmitter for an indefinite period. This instrument, in connection with the Eureka company's new double-pole receiver, makes a set that is adapted to any long-distance work that may be required of it. Further particulars regarding the apparatus may be obtained by addressing the company.

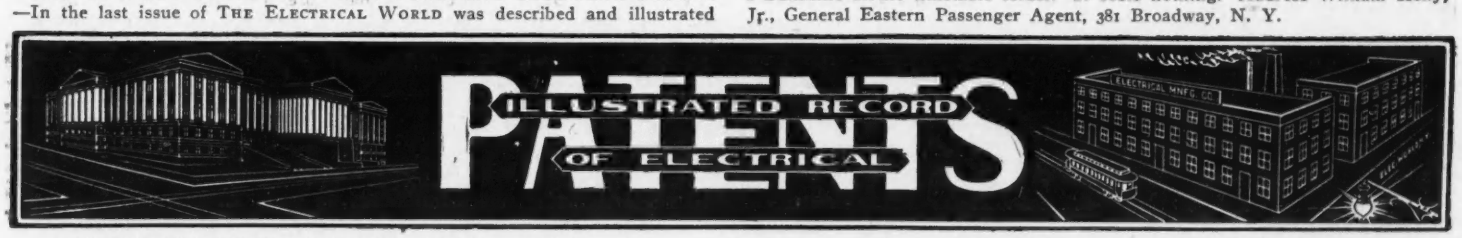
THE CHICAGO PUBLIC LIBRARY BUILDING LIGHTING PLANT.—In the last issue of THE ELECTRICAL WORLD was described and illustrated the lighting and power plant of the Chicago Public Library Building, Chicago, Ill. In this connection the Warren Electric & Specialty Company, Warren, Ohio, calls attention to the fact that the 13,000 incandescent lamps used in this building are of that company's make. The company furnished the lamps for the library last year and again, after careful tests, secured the contract for this year's supply. This library is said to be one of the most technical customers in the country, and the lamps supplied to it must be exact as to efficiency, maintenance of candle-power and must not vary more than 2 watts in a 16-cp lamp. Naturally the Warren Electric & Specialty Company feels that its product has received high endorsement in having been selected for use in this building.

THE ELECTROSE MANUFACTURING COMPANY, No. 127 North Tenth Street, Brooklyn Borough, New York City, reports the largest business in the history of the concern, and a constantly growing demand for its products in every branch of the electrical trade. Electrose, which is recognized as one of the best substitutes for hard rubber, has become a standard article in the electrical trade, especially among telephone manufacturers, for receiver cases, mouthpieces, etc. Mr. Louis Steinberger, the president of the company, who is also the inventor of electrose, has developed this material to its present high standard, and is still at work improving its qualities. Electrose is not only an insulating substance but it also has many of the other qualities of hard rubber. It is said to possess other qualities not found in the latter. The best evidence of the Electrose Company's success is the fact that it counts among its best patrons many of the leading electrical manufacturers throughout the United States and abroad.

SOME LARGE TRANSFORMERS.—The Wagner Electric Manufacturing Company, St. Louis, Mo., has secured through its manager of sales, Mr. E. H. Abadie, what is said to be the largest transformer order ever placed in this country. The contract was given by the Union Carbide Company for seven transformers of 2000-hp output capacity each and two of 500 horse-power each, complete with switchboards, for their operation. These transformers are to go into the Carbide company's works at Niagara Falls, N. Y., and are to be of the oil-type, with water coils for lowering the temperature of the oil. The contract was closed on definite specifications as to iron and copper losses, full load, three-quarters, one-half, one-quarter and one-tenth load efficiency, guaranteed as to temperature rise and also as to insulation test, and guarantees made as to 50 per cent. overload in current. As the electrical apparatus installed by the Union Carbide Company is subject to the approval of the Niagara Falls Power Company, and since Mr. L. B. Stillwell, the managing director of the latter company, has approved of the specifications agreed upon, this contract, it is claimed by the Wagner company, places it on record as the builder of the largest power-transmission transformers in the world. These tranformers, together with the 40,000-volt, high-tension transformers now operating at Provo, Utah, and Telluride, Col., the Wagner company claims, gives it a leading position among builders of large single-unit transformers for extremely high voltages. The company states that it is getting some very large orders for high-potential transmission transformers where the units range from 100 to 500 horse-power and the voltage as high as 40,000 volts.

Business Notice.

TO THE LAND OF SUNSHINE.—Take the Sunshine Route from Chicago to Los Angeles, San Francisco and other points in California, and escape the rigors of winter in the East and North. Pullman tourist cars for first and second-class passengers leave Chicago every Saturday at 2 o'clock P. M. via the Chicago, Milwaukee & St. Paul Railway to Kansas City, thence to California via the Atchison, Topeka & Santa Fé Railway—a real sunshine route. This is the earliest afternoon train leaving Chicago for the West after arrival of morning trains from the East, thus avoiding tedious delay. The Sunshine Route is essentially the best and most patronized through car line for men, women and children. Every attention paid to the needs of passengers en route. Send for a Sunshine Route timetable folder. It costs nothing. Address William Kelly, Jr., General Eastern Passenger Agent, 381 Broadway, N. Y.



UNITED STATES PATENTS, ISSUED DECEMBER 20, 1898.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

616,079. ELECTRICAL BURGLAR-ALARM. C. Coleman, of Chicago, Ill. App. filed June 29, 1896. In an electrical burglar-alarm system the combination, with a closed controlling circuit, of a plurality of interrupted circuits laid in reverse directions and charged with electricity at the same potential as is the controlling circuit, all of said circuits being insulated from each other and braided together.

616,082. THERMOSTATIC AUXILIARY FIRE-ALARM SYSTEM. A. H. Cross, of New York, N. Y. App. filed June 1, 1898. In an auxiliary fire-alarm system the combination with a street box of a normally closed auxiliary circuit, including a section of fusible wire extending throughout a building, and a compound of thermostatic wire arranged parallel to said fusible wire and normally disconnected from the auxiliary circuit, substantially as described.

616,104. PERMUTATION LOCK FOR BOXES. H. Hinterholzner, of New York, N. Y. App. filed Jan. 10, 1898. A locking device for locking a shiftable lid upon a box, comprising a base, integral with the box, a pivot turnably secured in the base, a slot and a circular recess at the end of the slot provided in the lid; a soft iron tumbler fitted into the circular recess, a block turnably mounted upon the pivot and provided with a bore corresponding in size and position relatively to the pivot with the circular recess in the lid; a disc or cover secured to the pivot, and a magnet affixed to the disc in corresponding position with the bore in block.

616,110. ELECTRIC SWITCH. W. J. Kelley, of Boston, Mass. App. filed May 1, 1897. In an electric switch, the combination of the following instrumentalities, viz., a rotatable shaft, a plurality of commutators loose thereon, means to rotate said commutators on said shaft, and means to connect the said commutators to said shaft to rotate therewith, substantially as described.

616,111. ARC-LIGHT REGULATOR. W. J. Kelley, of Boston, Mass. App. filed Jan. 29, 1896. In a regulator for automatic arc lights, the combination with a variable resistance composed of a series of resistances, increasing and diminishing irregularly, as described, to enable the arc lamp to be regulated without interfering with its functions, and a circuit controller co-operating with the said variable resistances, substantially as described.

616,136. AUXILIARY FIRE-ALARM TELEGRAPH APPARATUS. B. Oehmen, of New York, N. Y. App. filed Jan. 14, 1898. An improved double magnet, comprising two parallel coils, an armature co-operating with the poles of said coils at one end and being attracted so as to actually engage said

poles to close the magnetic field, and a second armature co-operating with the poles of the magnets at the other end.

616,148. MAGNETIC SWITCH. C. E. Scribner, of Chicago, Ill. App. filed April 23, 1897. The combination of a permanent magnet, an armature therefor, switch contacts controlled by the armature, a pole-piece of soft iron for said magnet presented to the armature, said pole-piece being removable and associated with a movable appliance, substantially as described.

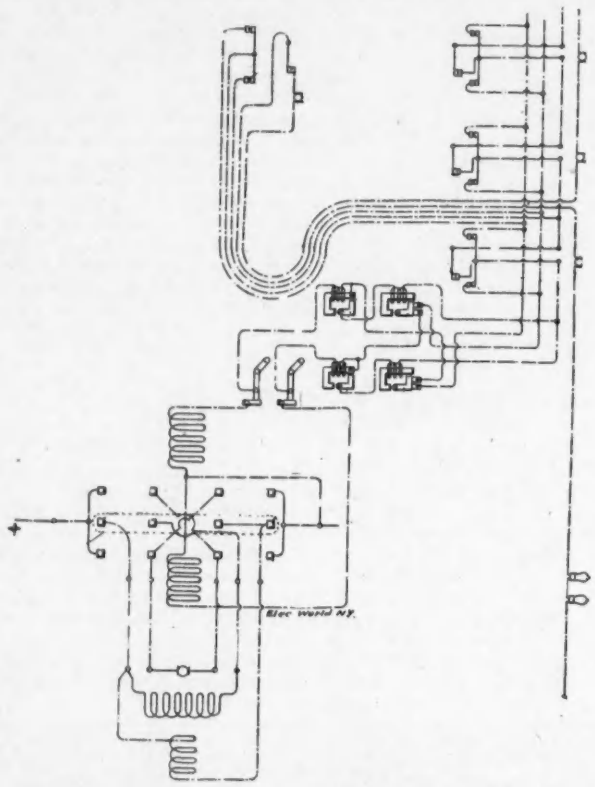
616,190. ELECTRIC OPERATING OF ELEVATORS BY THREE-BUTTON PUSH SYSTEMS. J. D. Ihlder, of Yonkers, N. Y. App. filed Dec. 16, 1897. In a system for the electrical operation of elevators, the combination with a motor and a reversing switch controlling the motor of a circuit including two sets of push-buttons, circuit-maintaining magnets, and non-interfering magnets controlling said circuit, substantially as described.

616,232. RAIL-BOND. W. E. Harrington, of Camden, N. J. App. filed April 9, 1898. In combination with abutting ends of railway rails a bonding member with smooth contacting surface adapted to contact therewith, and set-screws adapted to act upon said bonding member to maintain pressure between it and the rails, substantially as described.

616,265. FIELD MAGNET FOR ELECTRIC MACHINES. S. H. Short, of Cleveland, Ohio. App. filed July 28, 1898. A field magnet for electric machines having grooves formed in the pole-surfaces thereof, in combination with a grid arranged to be received in said grooves, substantially as described.

616,276. ILLUMINANT FOR INCANDESCENT ELECTRIC LAMPS AND PROCESS OF MAKING. O. W. Thowless, of Newark, N. J. App. filed Jan. 31, 1896. An illuminant for incandescent electric lamps, consisting of a carbon filament and a surrounding sheath or covering of oxide or other compound of thorium.

616,301. PNEUMATIC MOTOR FOR ELECTRIC APPLIANCES FOR CARS. C. A. Evans, of Upland, Pa. App. filed July 13, 1897. A car having depending hangers, a shaft mounted thereon, a wind wheel connected with said shaft, a casing surrounding said wheel, a damper on said casing, a clutch on the said shaft, means within the car for operating said clutch and adjusting said damper, and a dynamo having its shaft operated by that of the wind-wheel.



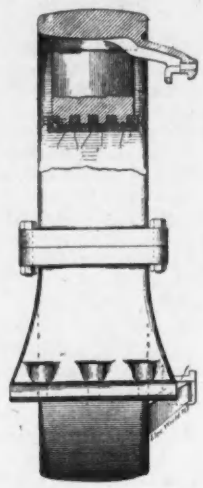
No. 616,190.—Electric Operation of Elevators by Three-Button Push Systems.

616,339. AMMETER FOR ALTERNATING ELECTRIC CURRENTS. W. A. Layman, of St. Louis, Mo. App. filed April 4, 1898. In an alternating or pulsating current ammeter, a suitable, fixed element, a suitable, movable element, a primary circuit for one of said elements, a secondary circuit for the other of said elements, and a transformer for supplying current to said secondary circuit at a substantial constant potential.

616,343. ELECTRIC GENERATOR FOR CYCLES OR OTHER VEHICLES. J. Moores and H. O. Farrell, of Manchester, England. App. filed May 24, 1898. An electric generator (to be applied to a cycle or other vehicle driven by one of the wheels thereof) mounted on a suitable stirrup in which the said generator can rock, the said stirrup being adjustable in a bracket fixed to the vehicle, substantially as described.

616,396. COMBINED BEARING AND POWER-TRANSMITTING DEVICE. C. O. C. Billberg, of Lewisberg, and P. A. N. Winand, of Philadelphia, Pa. App. filed Nov. 23, 1897. The combination in an electric motor of an armature and its shaft, a rotating, drum-like field magnet geared to said shaft, current collector rings mounted on the interior of said drum, and contact shoes or brushes bearing upon said rings.

616,403. SYSTEM OF ELECTRIC TRACTION. M. Cattori, of Rome, Italy. App. filed Dec. 24, 1897. An electric railway provided with two substantially parallel sectional conductors, arranged in two circuits, an independent generator included in each circuit, terminal switches whereby one pole of each generator may be connected with the corresponding terminal of either conductor of the same circuit, and junction switches whereby the other pole of each generator may be connected with the other end of either conductor of the same circuit.



No. 616,265.—Field Magnet for Electric Machines.

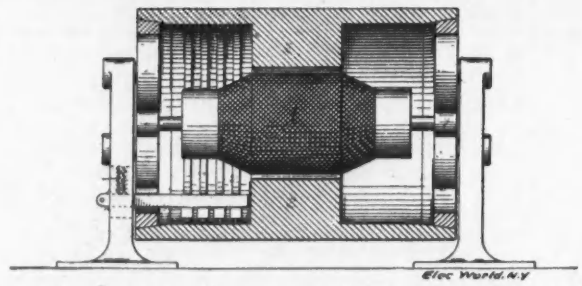
616,405. AUTOMATIC MAGNETIC CIRCUIT BREAKER. C. M. Clark, of New York, N. Y. App. filed May 27, 1898. A circuit breaker, comprising a rotary disc of insulating material, a contact block seated in said disc and extended through the same; fixed brushes normally engaging said block, one at each side of the disc, the said brushes being in an electric circuit; a solenoid in the circuit, a pivoted latch having connection with the solenoid core and normally engaging with a part on the disc, to hold said disc; a spring for moving the disc when released by the latch, and a blow-out in the form of a plate, having an opening through which the disc may move, the said plate being secured near the brushes.

616,417. INDICATOR. F. Hackmann, of Milwaukee, Wis. App. filed Nov. 26, 1897. In an indicator the combination of a printing wheel, a shaft on which said wheel is mounted, a spring connected at one end to said shaft and having its opposite end connected to the wheel, and a contact pin extending laterally from a recess of the printing wheel, and adapted, when the wheel is turned in a direction to wind the spring, to be pressed inwardly into the recess in order to clear a fixed point or stop of a framework.

616,165. CARBON FOR ELECTRIC WELDING. G. W. de Tunzelmann, of London, England. App. filed Feb. 25, 1898. An electrode for electric welding, brazing and the like purposes, composed of carbon and metallic oxides, combined together by admixture, substantially as described.

616,174. ELECTRIC VOTING MACHINE. F. S. Wood, of Boston, Mass. App. filed Jan. 16, 1897. In an electric voting machine, the combination in series of a plurality of first circuits adapted to transmit volting impulses whereby said circuits are made interdependent, one circuit of said series having its switching device adapted to open all the circuits when operated, while the other circuits have an auxiliary device co-operating therewith and producing the same result.

616,186. MICROPHONE CONTAINING GRANULAR CARBON FOR RETAINING MATERIAL IN POSITION. L. M. Ericsson, of Stockholm, Sweden. App. filed April 6, 1898. In combination, a microphone, a disc, a ring of elastic material surrounding the same and projecting beyond the face thereof, a diaphragm opposite the disc, carbon granules in the space bounded by the elastic ring, the disc and the diaphragm, and the spring for pressing the elastic ring toward the diaphragm, substantially as described.



No. 616,396.—Combined Bearing and Power-Transmitting Device.

616,436. ELECTRIC WELDING. H. F. A. Kleinschmidt, of Johnstown, Pa. App. filed Feb. 7, 1898. The method of electrically welding bars to the sides of rails, which consists in passing the heating current transversely through the bars and rail, forming the weld by laterally compressing the bars against the rail, and retaining said bars continuously under compression and in contact with cold conducting surfaces until they have cooled sufficiently to have lost substantially all appearance of glow.

THE ELECTRICAL WORLD

AN ILLUSTRATED WEEKLY REVIEW OF CURRENT Progress IN Electricity AND ITS PRACTICAL APPLICATIONS

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WRITE FOR CIRCULAR AND PRICES

The E. G. BERNARD COMPANY
Manufacturers of
DYNAMOS and MOTORS
TROY, N. Y.

A BOHEMIAN TESTIMONIAL.

PROCTOR'S THEATRE,
NEW YORK, October 12, 1897.

STANLEY & PATTERSON, New York City, N. Y.
GENTLEMEN—I find that the BOHEMIAN COLORING ENAMEL and FROSTING which you furnish for the lamps we use in our Living Picture Exhibition and other stage lighting gives excellent satisfaction. It has proved superior to genuine colored glass lamps, giving much better light. I have in the past ten years tried many kinds of coloring enamel, but the Bohemian is the best and the finish is as smooth as natural glass.
Yours truly, G. W. WHITTAKER, Electrician, Proctor's Theatre.

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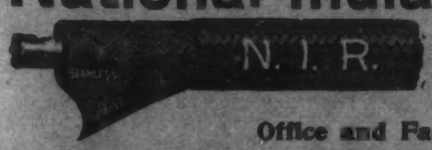

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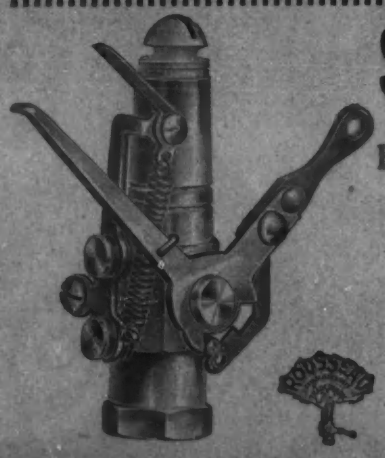

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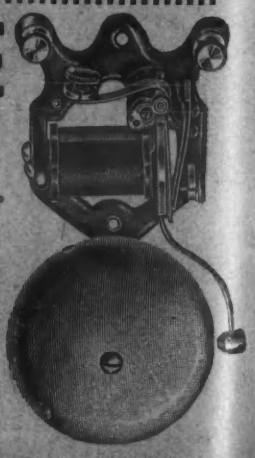

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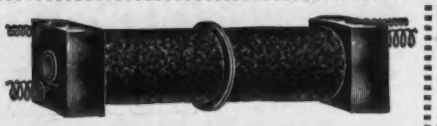

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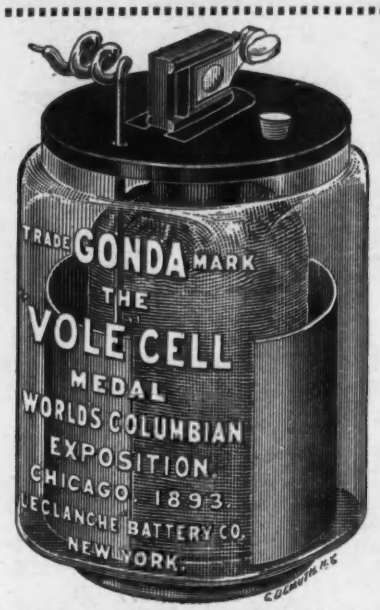

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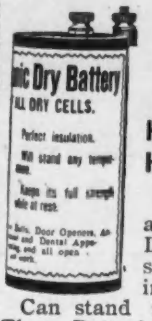

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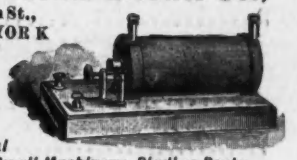

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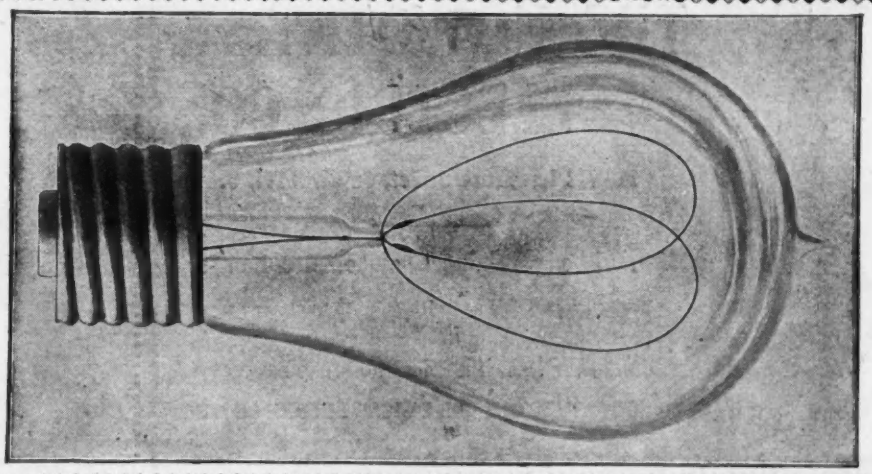

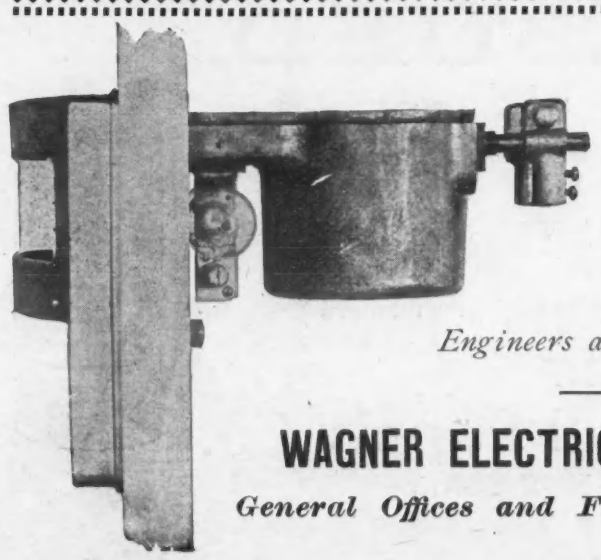

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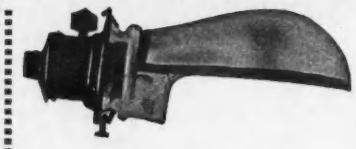

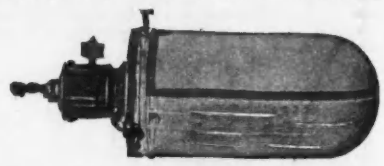

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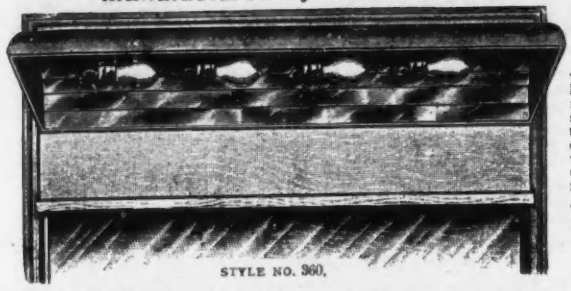

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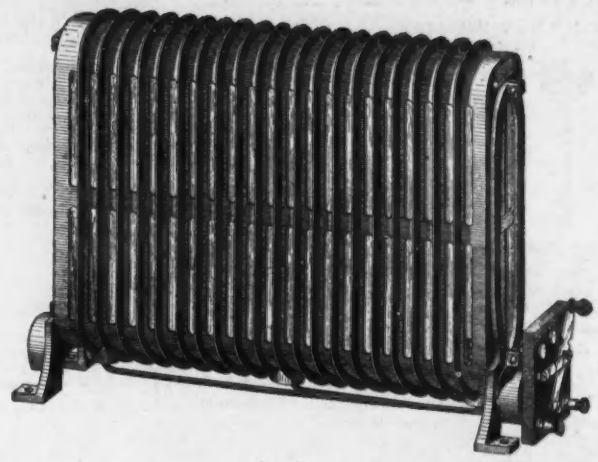

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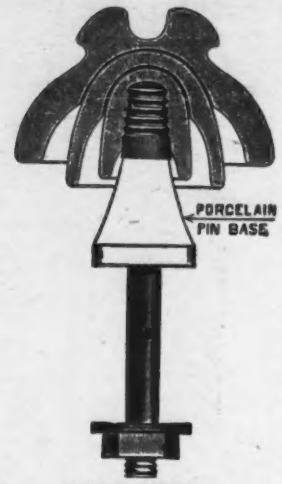

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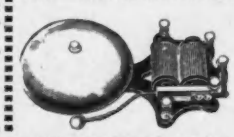

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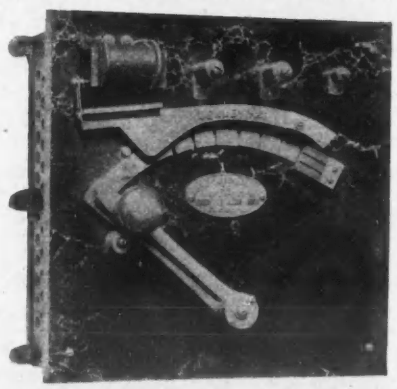

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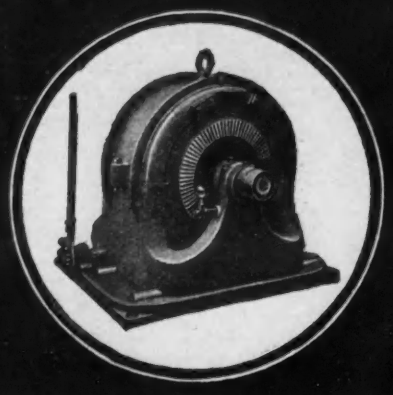

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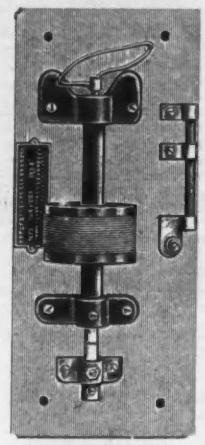

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surface=contact, closed=conduit

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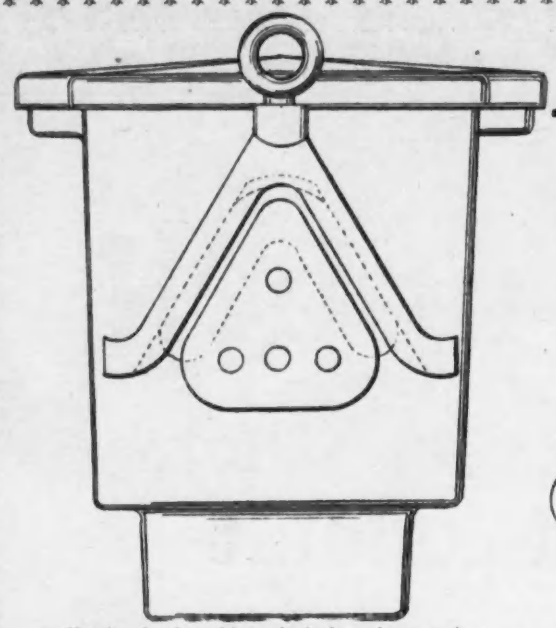

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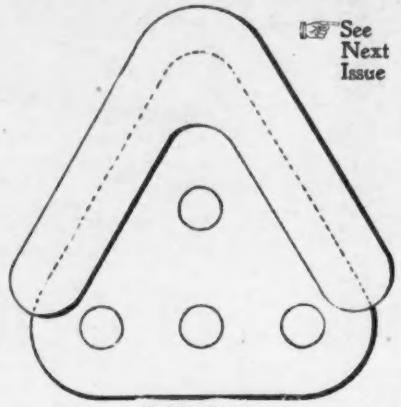

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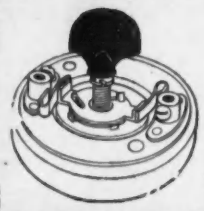

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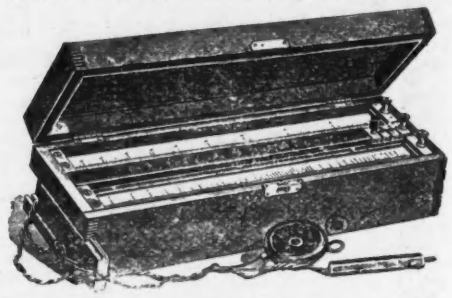

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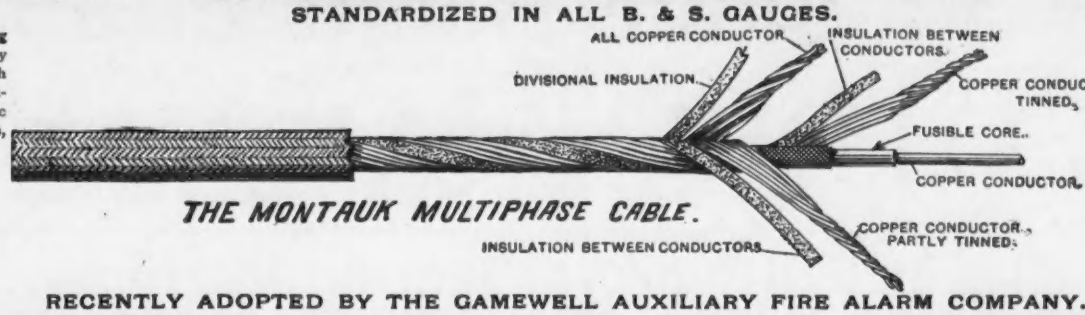

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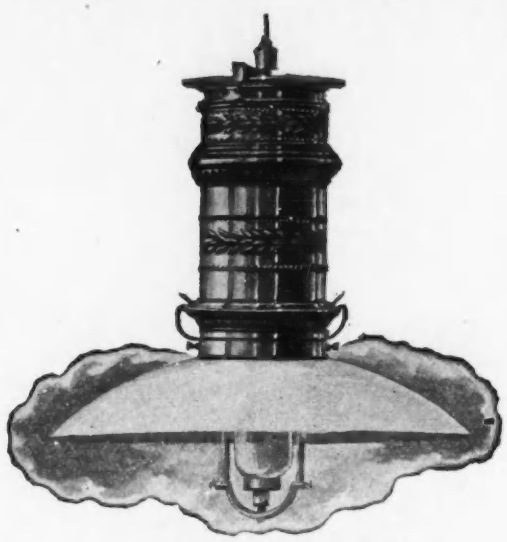

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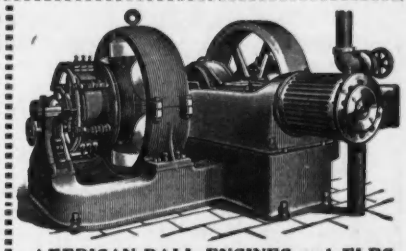

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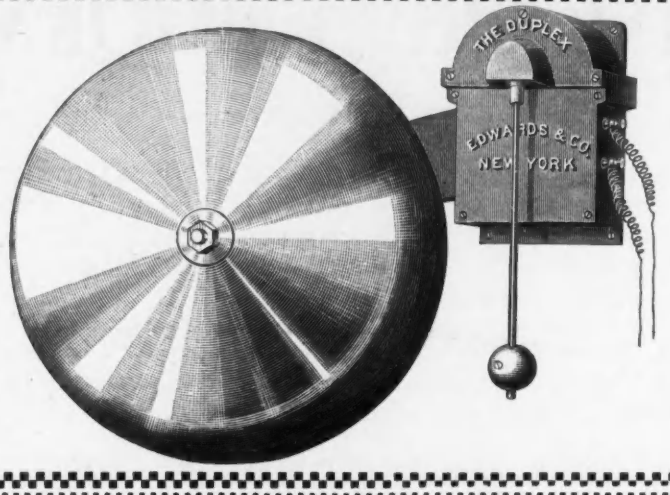

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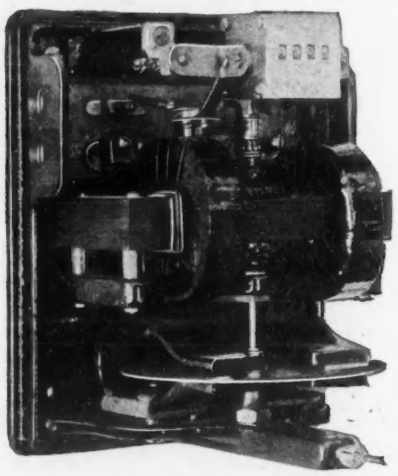

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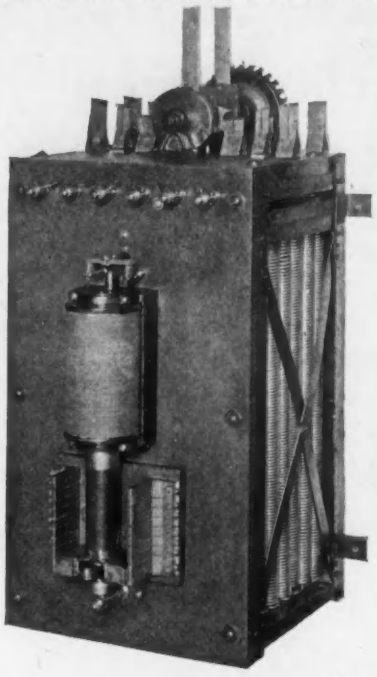

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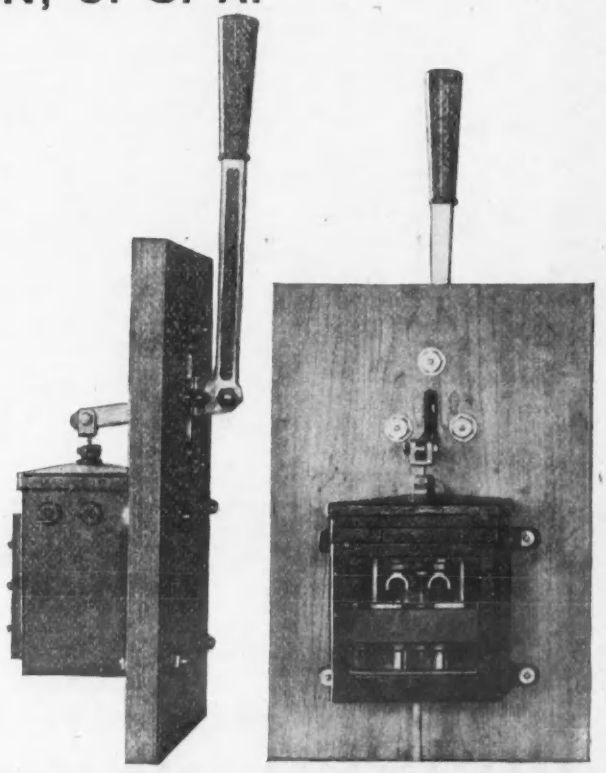

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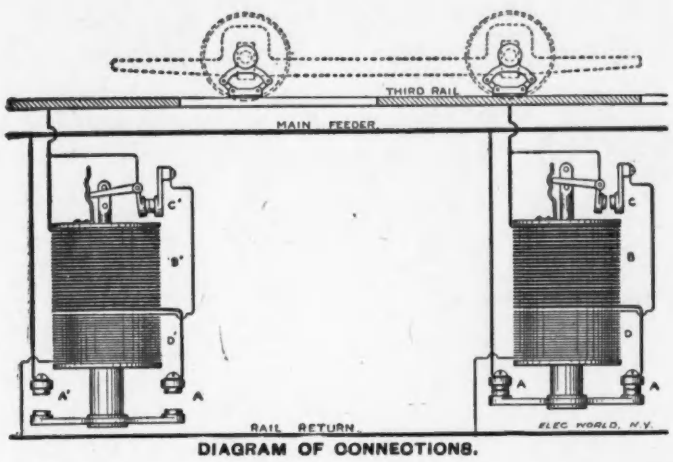

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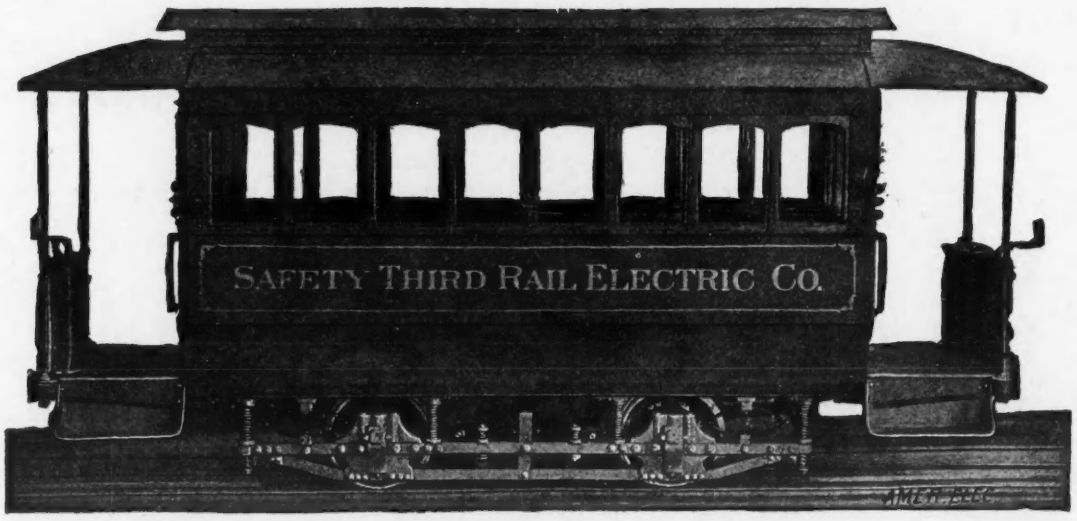

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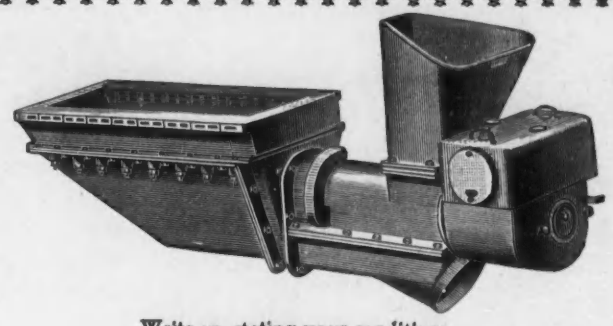

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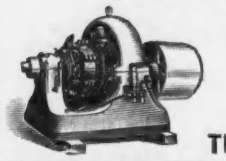

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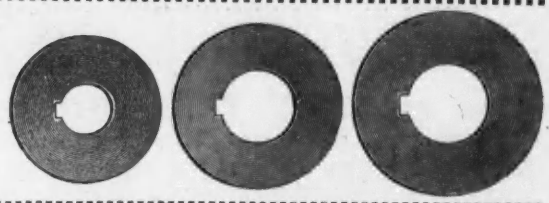

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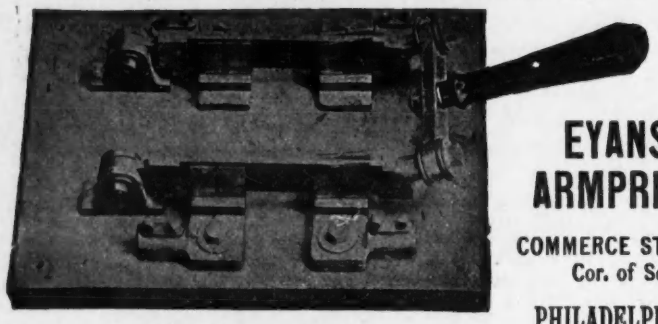

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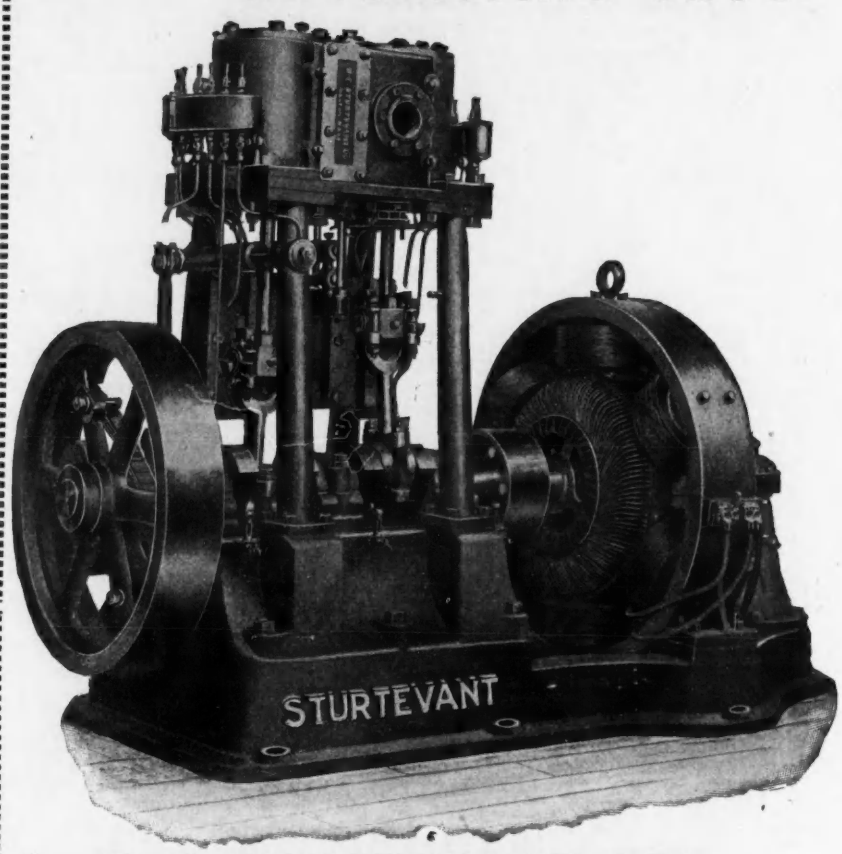

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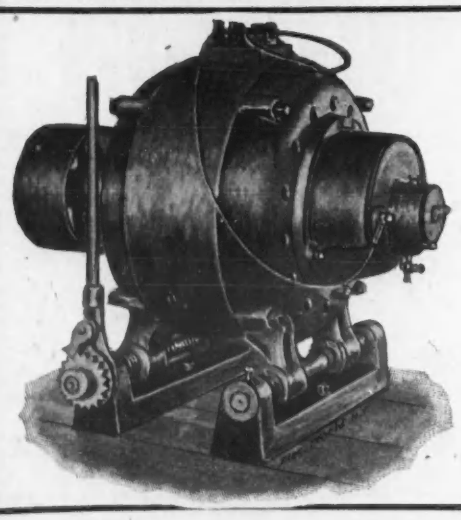

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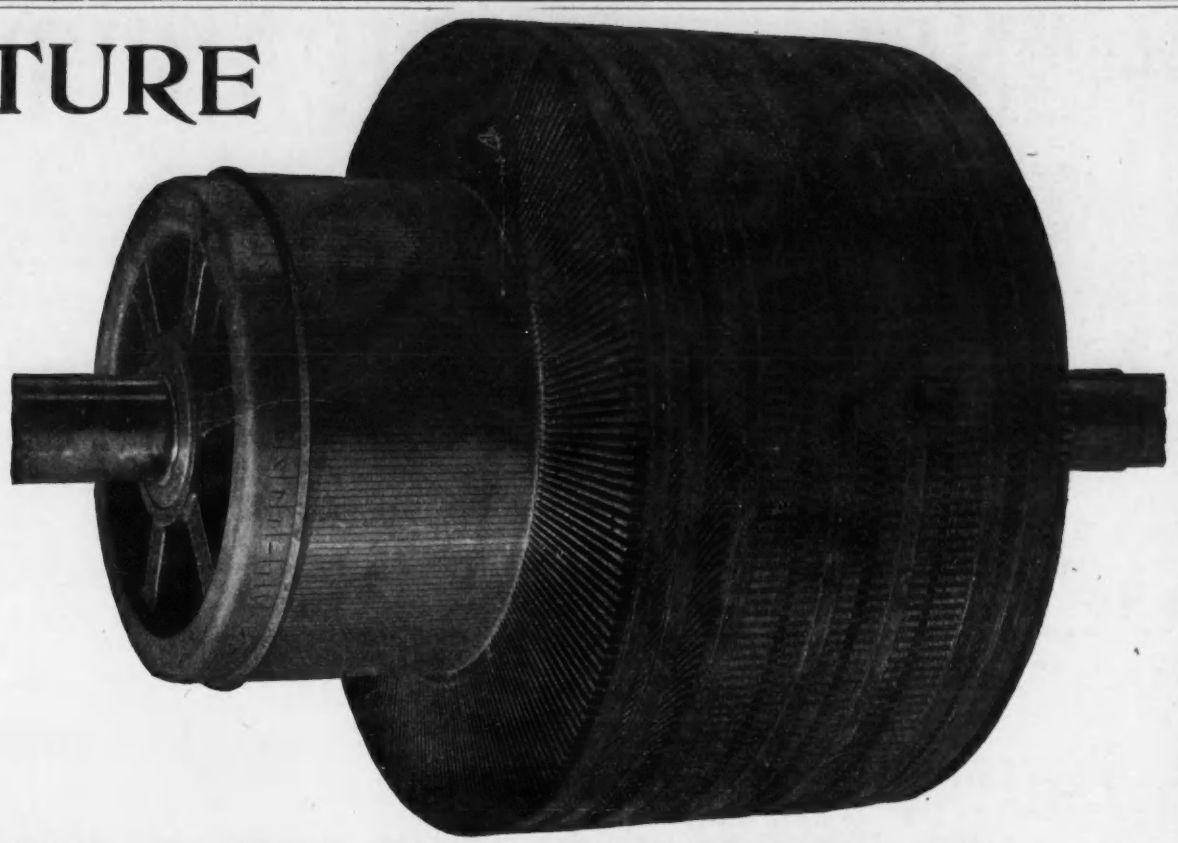

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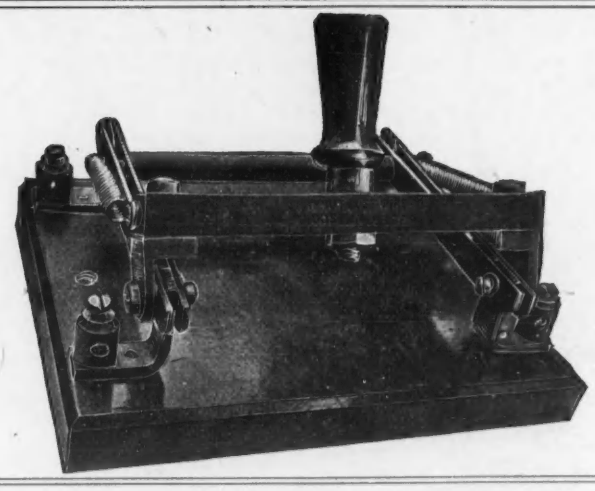

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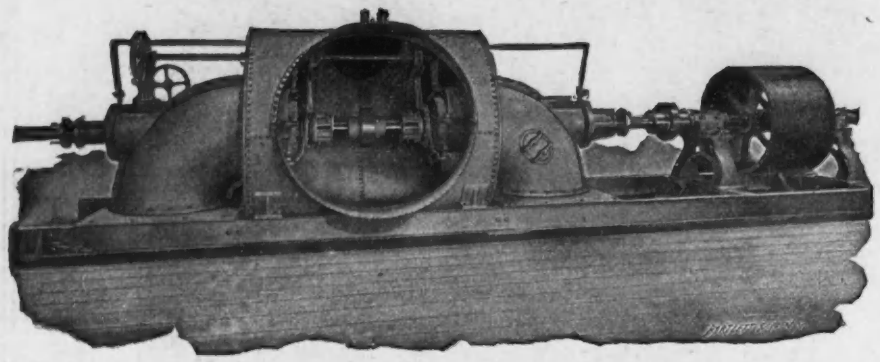

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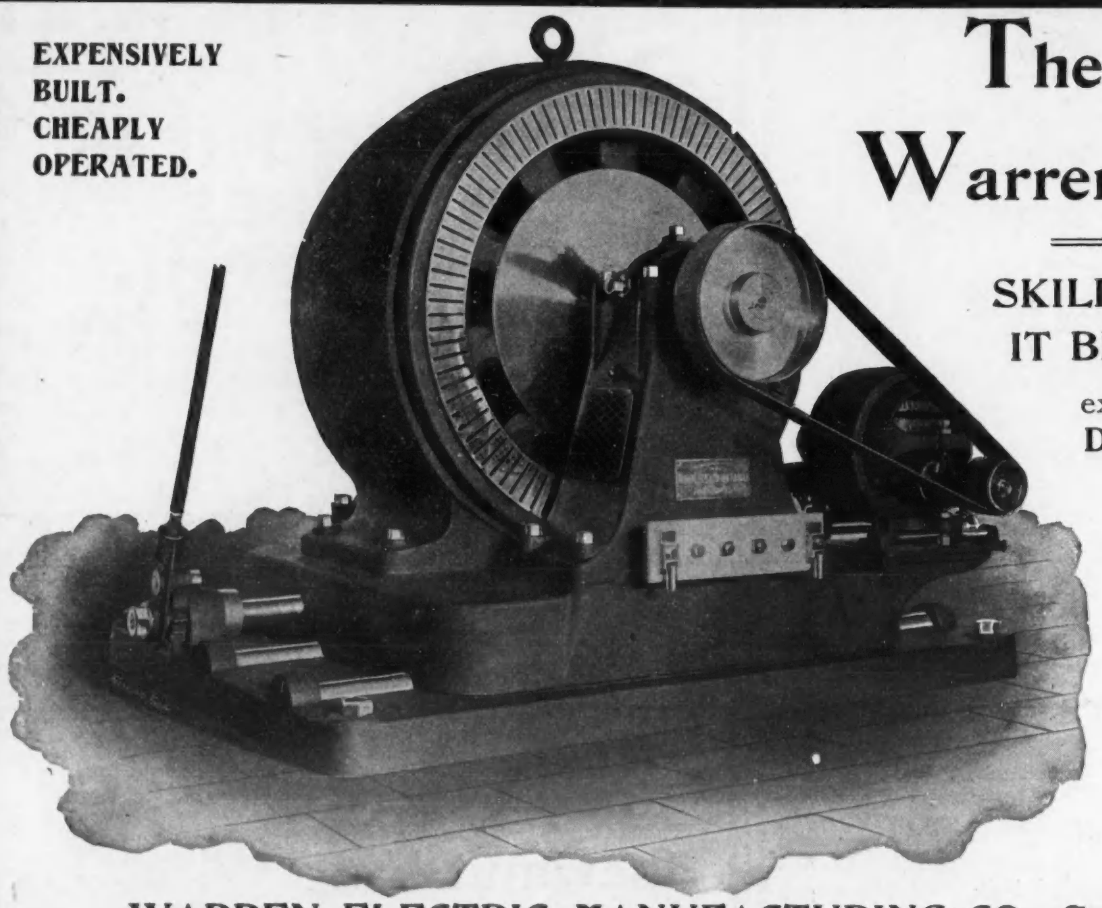

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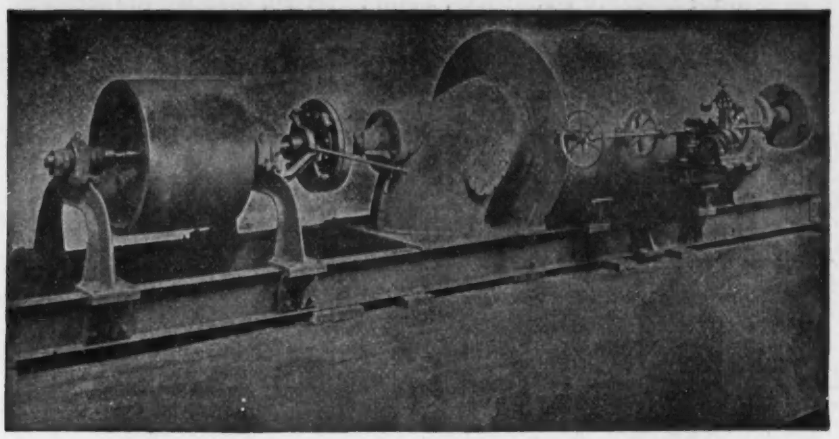

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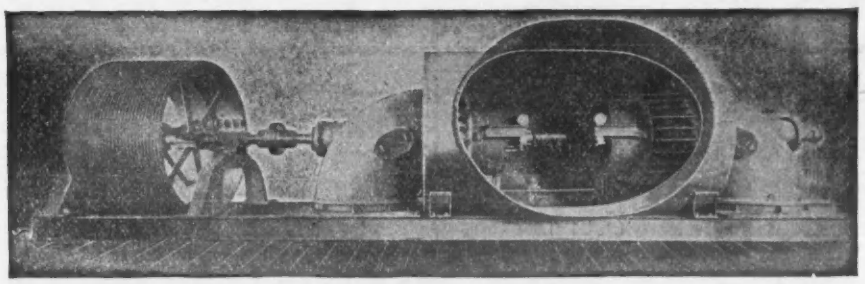

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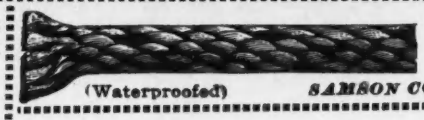

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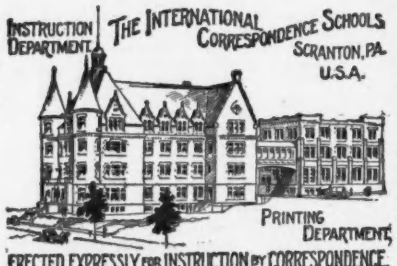

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Absolutely Will Not Gum the Brushes.
It will put that HIGH GLOSS ON THE COMMUTATOR you have so long sought after.
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WANTED—By a well-known electrical manufacturing company in Ohio a good electrician; one who is accustomed to drawing preferred; a good chance for the right man; state experience and salary expected. Address "OHIO," care The Electrical World, New York.

WANTED—A manufacturing company needs at once the services of a good man to assist in preparing a new catalogue of electric railway supplies; long experience in catalogue work is not particularly essential; what is wanted is a man familiar with the electrical trade and the goods that are marketable in the electric railway line and who has sufficient knowledge of catalogue work to know how to make a list of such goods; one familiar with proof-reading preferred; mention age, experience, references and salary, and address "RAILWAY SUPPLIES," care The Electrical World, New York.

POSITION WANTED—A successful electrical designer, inventor and engineer, who has been with the same company more than eleven years, would like to correspond with any company or person wanting such a man. Address H. E. HEATH, Windsor, Conn.

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Two M. P. 4-300-400 General Electric, with instruments.
One 150 K. W. multipolar Walker.
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Two 300 K. W. four-pole Westinghouse.
Two 250 H. P. No. 2 four-pole Westinghouse.
Two M. P. 4-200-425 General Electric.
One 125 K. W. six-pole Westinghouse.
Two M. P. 4-100-650 General Electric.
Two 100 K. W. Edison bi-polar.
Two M. P. 90 four-pole T.-H.
Two D-62 bi-polar T.-H.
Two 60 K. W. bi-polar Edison.

CAR MOTORS.

Lot of G. E. 800, 3 and 4 turn, drum armature type, practically new, very cheap.
Lot of No. 3 Westinghouse, 25 H.-P., first-class condition, very cheap,
Lot of W. P. 50's, good condition.
Extra armatures for all the above.

ALTERNATORS.

One 45 K. W. Westinghouse, 2,000 volts, 7,200 alternations, toothed armature with exciter and instrumen s.
One 240 K. W. Westinghouse, 1,000 volts, 16,000 alternations, iron-clad toothed armature, with exciter, etc.
Two 120 K. W. Westinghouse iron-clad toothed armature.
Two 60 K. W. Westinghouse, 1,000 volts, 16,000 alternations, iron-clad toothed armature.
One 45 K. W. Westinghouse, 1,000 volts, 16,000 alternations, toothed armature.
Two 30 K. W. Westinghouse, 1,000 volts, 16,000 alternations, toothed armature, with exciters.
Two A 120 K. W. General Electric, 1,000 volts, 16,000 alternations, toothed armature, with exciters and instruments.
One A 50 General Electric, 1,000 volt, with Exciter and Instruments; practically new; very cheap.
Two 60 K. W. General Electric, 2,000 volts, toothed armature, with exciters and instruments.
Two A 70 T.-H., 1 000 volts, 16,000 alternations, with exciters and instruments.
Two A 35 T.-H., 1,000 volts, 16,000 alternations, with exciters and instruments.
Two A 50 T.-H., 1,000 volts, 16,000 alternations, with exciters and instruments.
Two A 18, 300 light T.-H., 1,000 volts, 16,000 alternations, with exciter.
Two 750 light Westinghouse, 1,000 volts, 16,000 alternations, smooth body armature, very cheap.
One 120 K. W. Stanley, 16,000 alternations, 2 phase.
One 150 K.W. Ft. Wayne, 1.000 volts, 16,000 alternations, with exciter and instruments.
Two 60 K. W. Slattery, 1,000 volts, 16,000 alternations, very cheap.
One 2,000 light Slattery, very cheap.

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One 60-ampere, Letter Type, Westinghouse, compound wound.
Two 12 K. W. Edison, bi-polar, compound wound.
Two 30 K. W. General Electric multipolars; practically new.
Two 400 amp Westinghouse, 480 R. P. M., compound wound.
One 37 K. W. Westinghouse, compound wound.
Two 100 K. W. Edison bipolar.
Two 60 K. W. Edison bipolar.
Two 45 K. W. Edison bipolar.
Two 30 K. W. Edison bipolar.
Two 25 K. W. Edison bipolar.
Two 20 K. W. Edison bipolar.
Two 15 K. W. Edison bipolar.
Two 10 K. W. Edison bipolar.
One 7½ H. P. Eddy.
One 300 light horizontal type Westinghouse.
One 65 amp. Perret.

ARC DYNAMOS.

Two 125-light, 1,200 c. p., Brush, latest type.
Two 80 light Standard, 2,000 C. P.
One 75 light Ft. Wayne, 1,200 C. P.
One 75 light T.-H., 1,200 C. P.
Two 65 light Brush No. 8, 2,000 C. P.
Two 60 light Ft. Wayne, 2,000 C. P.
Two 50 light T.-H. M. D., 2,000 C. P., ring armature.
Two 50 light T.-H. L. D., 1,200 C. P.
Two 50 light 2,000 C. P. Brush, brand new.
Two 45 light 1,200 C. P. T.-H.
Two 45 light 1,200 C. P. Brush.
Two 30 light 2,000 C. P. T.-H.
Two 30 light 2,000 C. P. Brush.
One 30 light 1,200 C. P. Brush.
Two 25 light 2,000 C. P. T.-H.
One 20 light 2,000 C. P. Brush.

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We have on hand a large stock of T.-H. and Brush, double and single, 2,000 and 1,200 C. P., and would particularly mention some of the present type No. 31 Brush that are as good as new.

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One 12 K. W. Edison.
One 40 h. p. Crocker Wheeler.
One 60 K. W. United States.
One 7½ h. p., 220-volt, slow speed, multipolar, General Electric.
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One 7½ h. p., 220-volt, C & C.
One 50 K. W. D 50 T.-H.
Two 10 H. P. 500 volt Eddy.
Two 7½ H.-P 4 pole 500 volt Eddy.
Two 5 H.-P. 500 volt Eddy.
Two 3 H.-P. 500 volt Eddy.
One 1 H.-P. 500 volt Eddy.
Three 5 H.-P. 6 pole 500 volt Perret.
One 2½ H.-P 6 pole 500 volt Perret,
One 1 H.-P. 6 pole 500 volt Perret.
One 10 H.-P. 500 volt Westinghouse.
One 6 H.-P. 500 volt Mather.
One 5 H.-P. 500 volt Connecticut.
Two 1 H.-P. 500 volt Lundell.
One 7½ H.-P. 500 volt Holtzer-Cabot.
One 5 H.-P. 500 volt Holtzer-Cabot.
One 2½ H.-P. 500 volt Holtzer-Cabot.
Two 10 H.-P. 220 volt Electro-Dynamic.
One 15 H.-P. 220 volt 6 pole Perret.
One 12 H.-P. 220 volt C & C.
One 6 H.-P. 220 volt Jenny.
One 3 H.-P. 220 volt Sprague.
One ½ H.-P. 220 volt Eddy.
A number of others of smaller size, 110 volts.

TRANSFORMERS.

We have on hand a large stock of Stanley and T.-H. type F converters, 1,000 volts primary, 50 or 100 secondary, which we are selling at a very reasonable price. They are practically new, and were replaced immediately after being purchased for the reason that it was necessary to adopt 2,000 volts. They have all been put through the factory.

Write for our List of these Transformers.

Every machine guaranteed to be in absolutely first-class condition.
If you need anything that is not on this list write to us anyway, as we can almost certainly secure it for you.

ENGINES.

One Wright Corliss 800 h. p., high pressure cylinder, 20½ in.; low pressure cylinder, 40¼ in.; stroke, 36 in.; twin compound; very cheap.
One 450 h. p. McIntosh-Seymour, compound, 41½ in.x23 in.x22 in.
One E. P. Allis Corliss, compound tandem, 20 in.x30 in.x48 in.; practically new.
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Several others.

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110-Volt Dynamos.

1	50-light		Jenney.
1	55	"	Edison.
1	55	"	E. & C., Multipolar.
1	90	"	Westinghouse.
1	140	"	Ft. Wayne Jenney.
2	150	"	Eddy.
1	200	"	Western Electric.
1	250	"	T.-H.
2	270	"	General Electric, direct connected to Case engine.
1	280	"	Gen'l Electric, M. P.
1	325	"	Amer. Eng. Co., M. P.
4	350	"	Edison, 20 K. W.
1	425	"	United States.
2	480	"	Brush.
1	540	"	Lounsbury, M. P.
1	540	"	Edison, 30 K. W.
1	800	"	Rockford.
1	1000	"	Jenney.
1	1000	"	Edison, 60 K. W.
2	1500	"	Edison, 100 K. W.

220 Volt Dynamos.

1	7	K. W.	E. & C., Multipolar.
1	8½	"	Fisher, M. P.
1	12	"	Edison.
1	15	"	T.-H.
2	20	"	Edison.
1	20	"	T.-H.
1	20	"	Amer. Eng. Co., M. P.
1	25	"	Rockford.

500-Volt Generators.

1	15	K. W.	Edison.
1	18	"	Commercial.
1	18	"	E. & C., Multipolar.
1	20	"	T.-H.
1	25	"	Rockford.
1	25	"	General Electric, direct connected.
1	30	K. W.	Jenney.
1	45	"	Edison.
2	100	"	Edison, No. 32.
1	150	"	Westinghouse, M. P.

Alternators.

1	350-light		T.-H., A18.
1	400	"	T.-H. Iron Clad.
1	500	"	Standard, 30 K. W.
1	500	"	Bain.
1	500	"	Westinghouse, No. 0.
1	600	"	T.-H., 30 K. W., 2 phase.
1	600	"	Westinghouse, 30 K. W., toothed armature.
3	650	"	T.-H., A 35.
3	750	"	Westinghouse, 37½ K. W.
3	750	"	Westinghouse, self-oilers.
1	900	"	Westinghouse, 45 K. W., toothed armature.
1	1000	"	Westinghouse, 2-phase, toothed armature, 50 K. W.
2	1300	"	Slattery.
3	1500	"	Westinghouse, 75 K. W.

Arc Dynamos.

1	20-light	1200	c. p.	Excelsior.
1	20 "	2000	"	Excelsior.
1	20 "	2000	"	Western Electric.
1	20 "	2000	"	Brush.
1	25 "	2000	"	Thomson-Houston.
1	25 "	1200	"	Ft. Wayne, Wood.
1	30 "	1200	"	T.-H., K 12.
1	30 "	2000	"	T.-H., M 2.
3	30 "	2000	"	Brush.
3	35 "	2000	"	T.-H., L. D. 2.
1	40 "	2000	"	Western Electric.
2	45 "	1200	"	T.-H., M 12.
4	45 "	1200	"	Brush, No. 7.
2	50 "	2000	"	T.-H., M. D.
1	50-light	1200	c. p.	T.-H., L. D. 12.
1	50 "	1200	"	Standard.
1	50 "	2000	"	Standard.
1	50 "	2000	"	Brush, No. 7½.
1	50 "	2000	"	Excelsior, new type.
6	65 "	2000	"	Brush, No. 8.
1	100 "	2000	"	Western Electric.

110-Volt Motors.

2	¼	H. P.	Sprague.
1	3	"	Jenney.
1	3	"	E. & C., M. P.
1	4	"	Edison.
2	10	"	Eddy.
1	12	"	Western Electric.
1	18	"	Triumph.
1	20	"	General Electric, M. P.
4	25	"	Edison, 20 K. W.
1	25	"	Amer. Eng. Co., M. P.
1	35	"	Edison, 30 K. W
1	35	"	Lounsbury, M. P.
1	50	"	Rockford.
1	75	"	Jenney.
1	75	"	Edison, 60 K. W.
2	125	"	Edison, 100 K. W.

220-Volt Motors.

1	½	H. P.	Elliott-Lincoln, M. P.
1	¾	"	Hawkeye.
1	1	"	C & C.
1	3	"	E. & C., Multipolar.
1	4	"	Edison
1	6	"	Bernard.
1	7½	"	E. & C., Multipolar.
1	10	"	Belding.
1	10	"	Eddy.
1	10	"	Fisher, M. P.
1	15	"	Eddy.
1	15	"	Edison, 12 K. W.
1	18	H. P.	T.-H.
1	25	"	T.-H.
2	25	"	Edison.
1	25	"	Amer. Eng. Co.
1	30	"	Rockford.

500-Volt Motors.

1	1	H. P.	Westinghouse.
1	1	"	Eddy.
1	2	"	Crocker-Wheeler.
1	3	"	Jenney.
1	4	"	Edison.
1	5	"	Wood.
1	5	"	Westinghouse.
1	5	"	Detroit.
1	7½	"	T.-H.
1	7½	"	Commercial.
1	7½	"	Edison.
2	7½	"	E. & C., Multipolar.
1	10	"	Card.
1	10	"	Eddy.
2	12	"	T.-H, D 10.
1	15	"	Mather.
1	15	"	Card.
1	18	"	Edison, 15 K. W.
1	20	"	Commercial.
1	22	"	E. & C., Multipolar.
1	25	"	T.-H.
1	30	"	Rockford.
1	30	"	E. & C., Multipolar.
1	35	"	Jenney.
2	125	"	Edison, No. 32.

Alternating Motors.

1	½	H. P.	Stanley, single phase.
1	2	"	Stanley, two phase.
6	3	"	Westinghouse, two phase.
1	20	"	General Electric, monocyclic.
1	30	"	General Electric, monocyclic.
1	50	"	General Electric, monocyclic.

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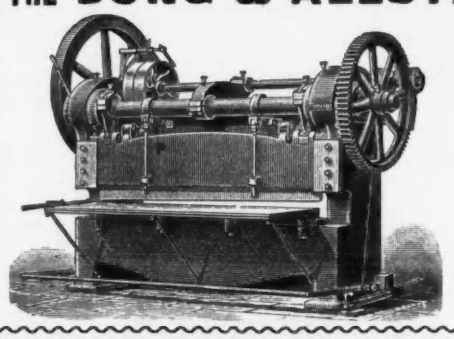

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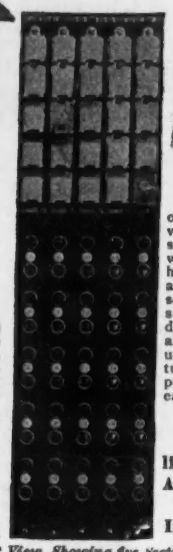

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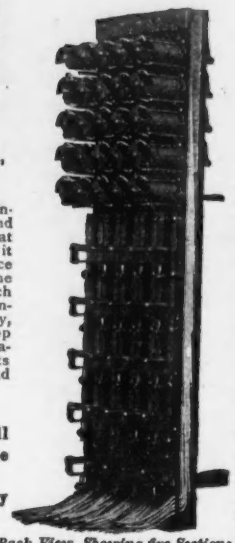

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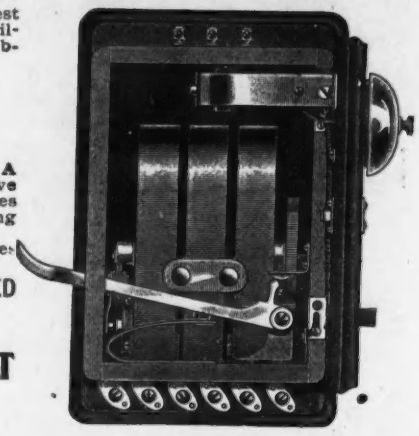

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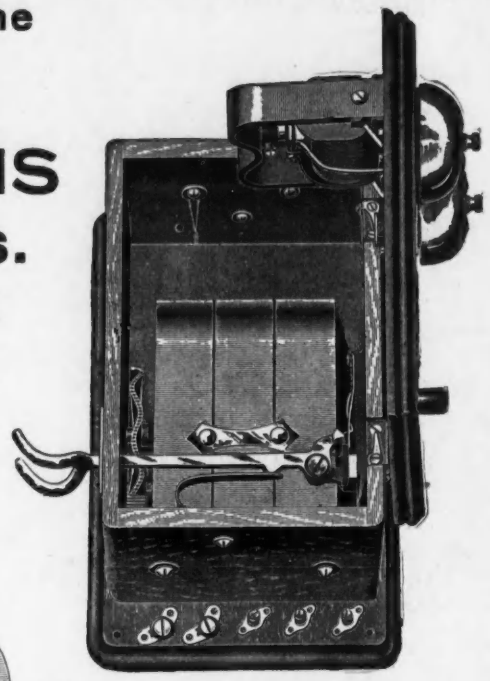

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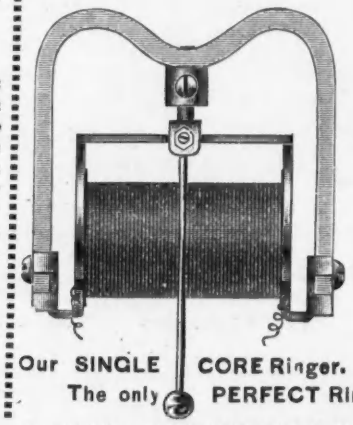

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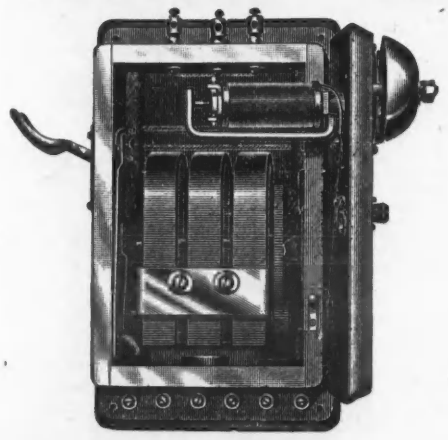

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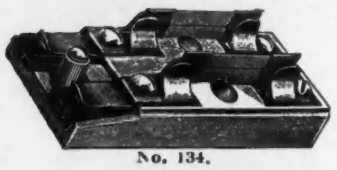

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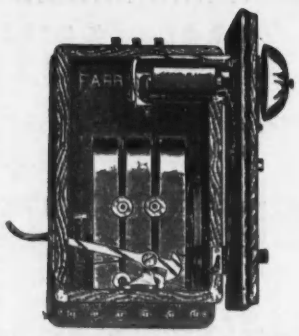

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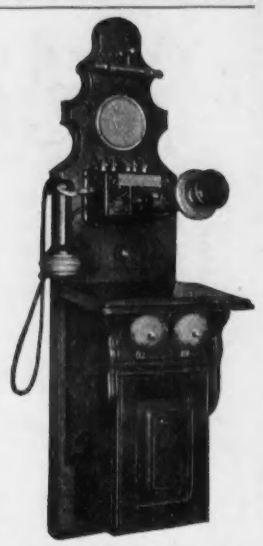

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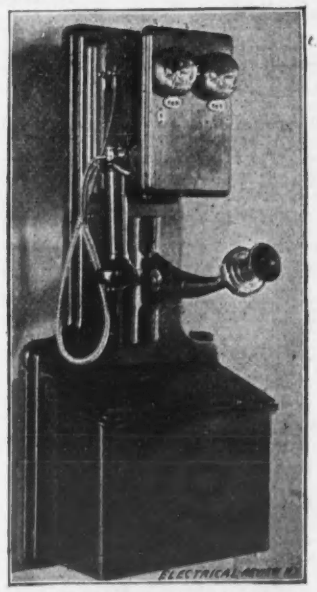

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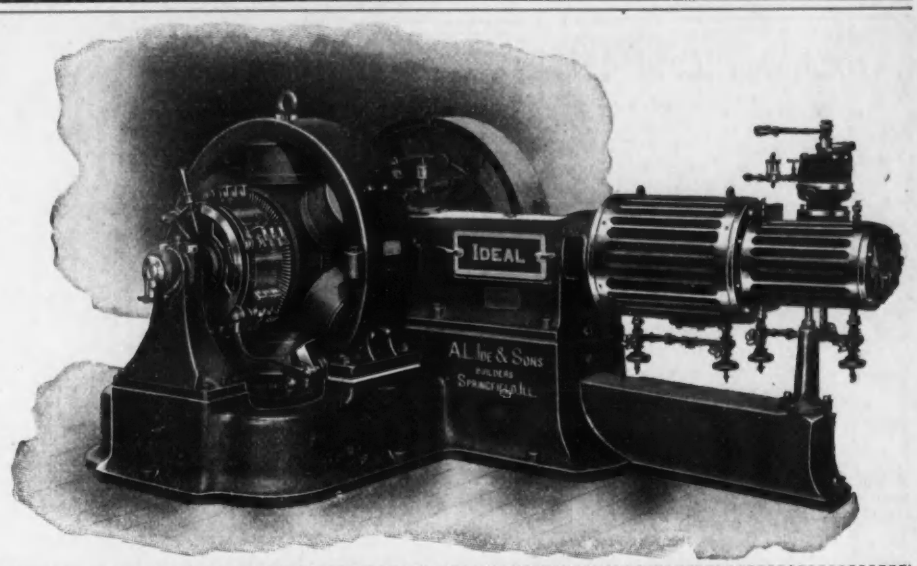

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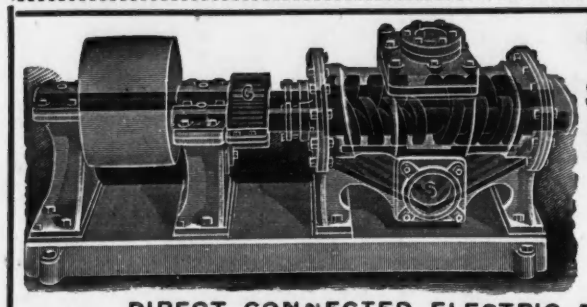

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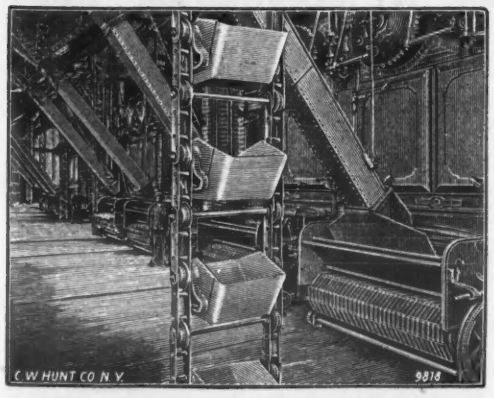

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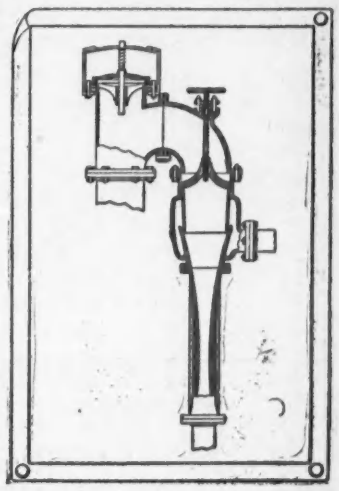

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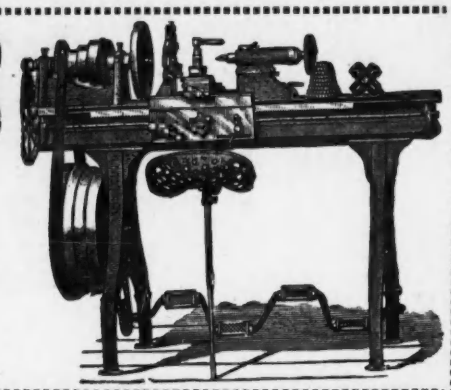

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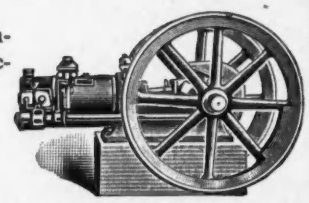

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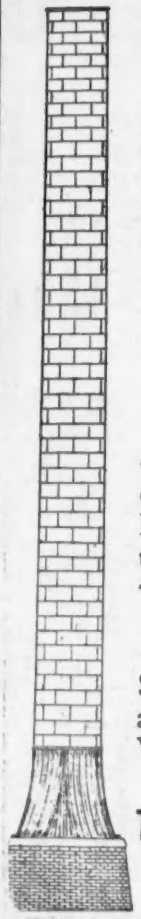

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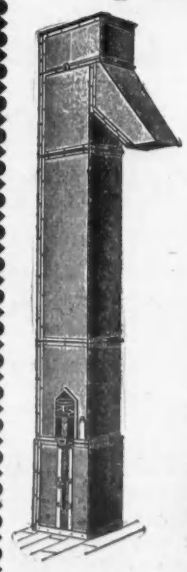

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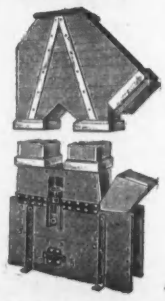

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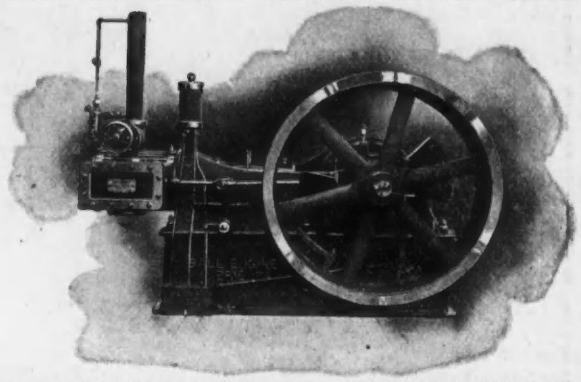

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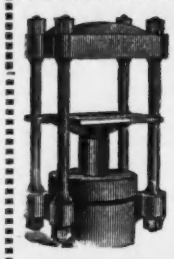

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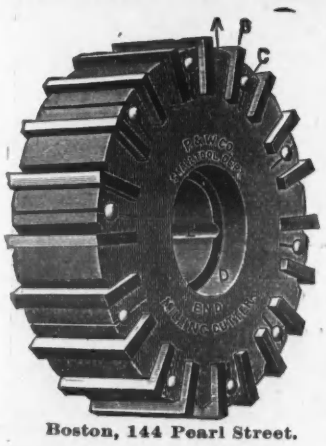

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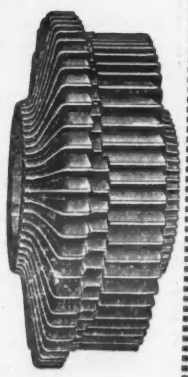

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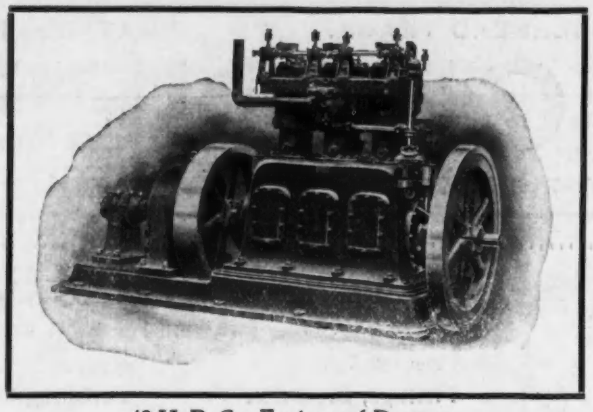

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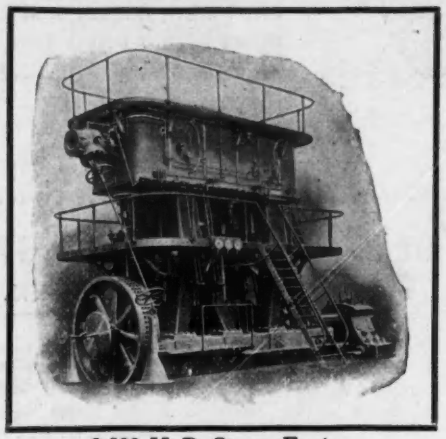

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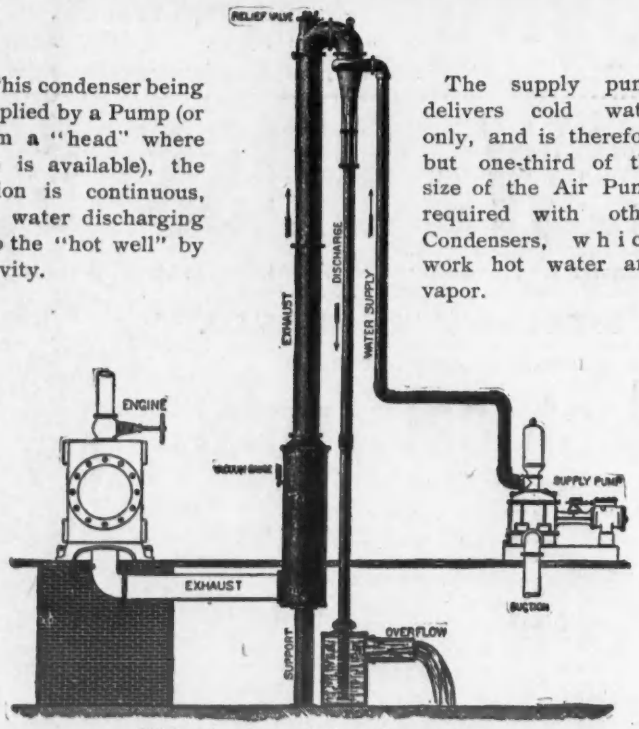

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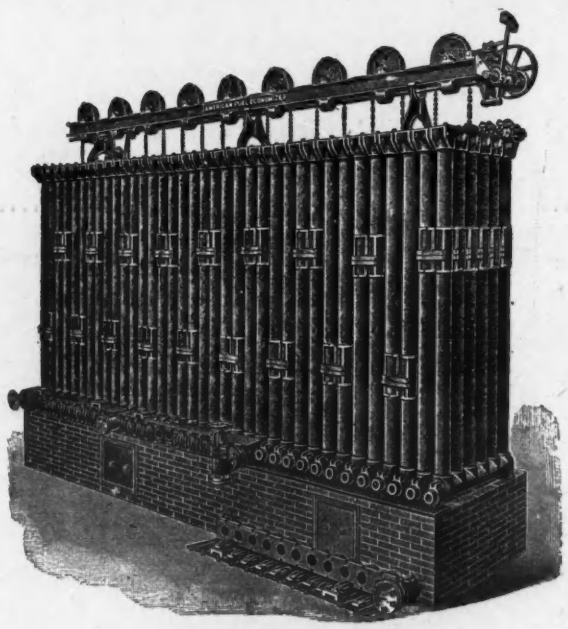

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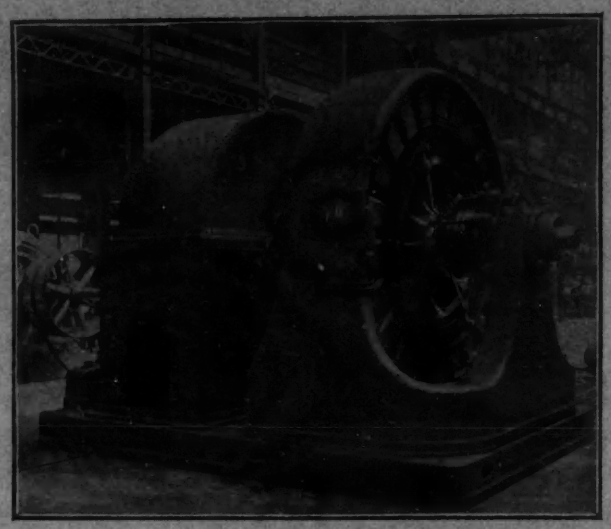

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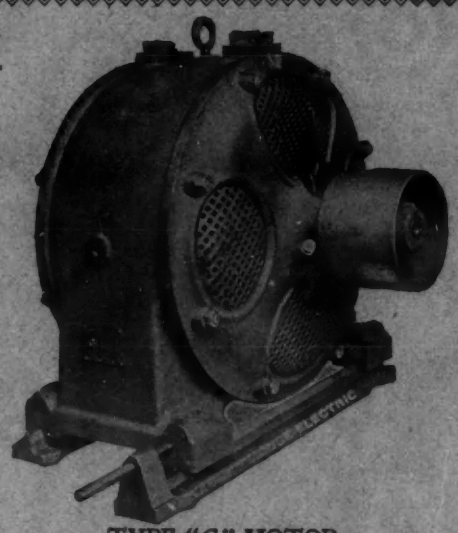

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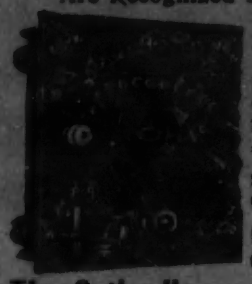

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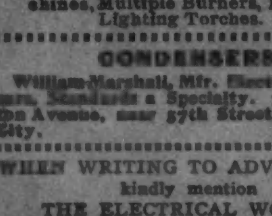

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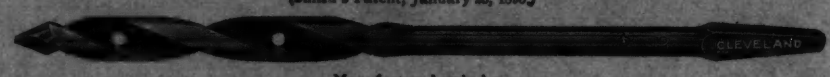

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